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ABSTRACT

The National Association for Research in Science Teaching sponsored a three-day research training program in Chicago, November 11-14, 1969. Supported by a grant from the U.S. Office of Education, the program was designed to improve the research competence of individuals involved with the training of future researchers. Fifty-two participants received training during the three-day program. Participants were primarily college and university professors involved in training future research workers. Training sessions were of two kinds: work sessions were led by leaders in specific research areas; problem sessions were led by senior participants for the purpose of examining ways in which skills taught in work sessions could be applied to specific research problems in science education. Evaluation by the session leaders and the participants indicated that the program was successful in imparting new research competencies and suggesting promising areas for future research. The conclusion was that similar training programs should be held in the future, with some modifications indicated in the evaluation material. (Author/RR)

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Final Report

A RESEARCH TRAINING PROJECT IN SCIENCE EDUCATION

Sponsored By

THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

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Abstract

The National Association for Research in Science Teaching sponsored a three-day research training program in Chicago, November 11-14, 1969. Supported by a grant from the U. S. Office of Education, the program was designed to improve the research competence of individuals involved with the training of future researchers. Fifty two participants received training during the three-day program, the first of its kind with U.S.O.E. support.

Training sessions were of two kinds. Work Sessions were led by leaders in specific research areas, and these constituted the primary training effort with specific research skills taught during these sessions. Problem Sessions were led by senior participants for the purpose of examining ways in which skills taught in Work Sessions could be applied to specific research problems in science education.

Participants were primarily college and university professors involved in training future research workers. Evaluation by the session leaders and the participants indicated that the program was successful in imparting new research competencies and suggesting promising areas for future research. The unanimous conclusion was that similar training programs should be held in the future, with some modifications indicated in the evaluation material.

THE NARST RESEARCH TRAINING PROGRAM IN SCIENCE EDUCATION

Program Overview

For over forty years the National Association for Research in Science Teaching has conducted a number of activities toward the end of improving research in science education. Most of the research published relative to the teaching of science in the past forty years has been work done or supervised by members of NARST. The quality of this research has been spotty, although there are clear indications that better research techniques and methods have been employed in more recent years. Nevertheless, it is equally evident that there has been substantial need for improvement in the general level of the science education research efforts. It was to this end that NARST sought support from the U. S. Office of Education for the conduct of a research training program.

A preliminary program was assembled by the Project Director with counsel from various board members of NARST and other individuals. A copy of the preliminary program is included in Appendix A-1. It was planned that a meeting of several leadership personnel to be involved in the training program would take place prior to the training sessions in order to coordinate and refine plans for the sessions. This meeting was held in Chicago on September 26, 1969. It was decided at this meeting that two kinds of sessions should be held. The first sessions, called Work Sessions, were to be the primary vehicle for training participants in specific research skills. These sessions were to be led by individuals with established reputation in their specific areas of competence. All participants in the training program were to select one series of Work Sessions and to continue with these Work Sessions through the three day training program. A second series of sessions, called Problem Sessions, was designed to focus on specific problems in science education to which the research skills presented in the Work Sessions could be applied. The Problem Session also was to serve as an opportunity for more informal discussion among trainees. A final program was prepared and this is shown in Appendix A-2.

In order to provide all participants with some introduction to the research competencies to be developed in each of the Work Sessions, brief descriptions of each of the six Work Sessions were presented by the session leaders during the first day of the training program. Dr. Henry Walbesser, University of Maryland, presented some of his views on the improvement of science research specifically referring to the need for clear specification of objectives in research. He indicated that his training sessions would provide practice with some techniques and skills needed in science education research. Dean J. Myron Atkin, University of Illinois, took a position somewhat different from the other Work Session leaders and described some issues in determining research priorities that influence policy decisions in education. Dean Atkin's presentation on Wednesday and a longer presentation to the entire group on Thursday morning raised issues regarding the narrow definition of research in education and the application of this kind of research to policy decisions in curriculum design and support of educational investigation. Dr. Wayne Welch, University of Minnesota, introduced a number of issues involved in the evaluation of curriculum. Drawing on his experience from Harvard Project Physics and from other curriculum evaluation programs, Dr. Welch led sessions focusing on research methodology appropriate to curriculum evaluation. Dr. John A. Easley, University of Illinois, used video tape to illustrate how conceptual analysis of classroom and clinical interview behavior could be conducted. His sessions included the viewing of video tapes and the development of skills involved in clinical research with children in classroom settings. Dr. Duncan Hansen, Florida State University, provided participants an opportunity to study specific computer capabilities as they can be involved in curriculum design and in analysis of outcomes during the course of curriculum design. Dr. Joseph D. Novak, Cornell University, showed how the application of learning theory to the formulation of research studies might lead to broader generalizability for research studies. The learning theory of David Ausubel was presented and participants had an opportunity to practice applying constructs from this learning theory to the design and interpretation of research.

Nine Problem Sessions were established, each chaired by participants in the training program who have had considerable experience in the area of the Problem Session. The Problem Sessions served as a vehicle for participants to identify ways in which knowledge obtained in Work Sessions could be applied to specific problem areas in science education. These sessions comprised a different mix of participants than that of the Work Sessions, hence enhancing exchange of ideas. A list of the sessions and chairmen is given in Appendix D-2.

The lunch hour, dinner hour and evening times were left free for informal participant discussion. Many small groups met to continue discussions initiated in the Work Sessions or Problem Sessions. Additional areas of concern in science education research also were explored by the participants during these unscheduled hours.

A brief summary session was held on Friday afternoon. The intent was less to summarize the training sessions than to provide an opportunity for group feedback which might be useful in the planning of future training programs. Following the training sessions, a questionnaire form was mailed to all participants and their responses are reported below.

Participants in the Research Training Program

A program announcement was prepared and mailed to all members of the National Association for Research in Science Teaching. Announcements of the research training program were also sent to the following journals: The Science Teacher, Science and Children, The Journal of Chemical Education, and The American Biology Teacher. It was evident from the kind of applications received that these announcements succeeded in attracting a significant number of applicants. A copy of the program announcement and application form appears in Appendix A-1.

In spite of a relatively tight time schedule, over 350 completed application forms were returned. All but three of these applications came from individuals who reported no prior attendance at a research training program sponsored by the American Educational Research Association. It is evident that we reached a population of research workers with this program that has been largely untouched by the research training efforts of AERA. Many of the applicants were classroom teachers at the elementary and secondary level. Since the primary objective of the research training program was the training of individuals actively involved in the supervision and training of research workers, very few of the participants came from public schools. A list of the participants is included in Appendix B-1. A summary of the data on the application form is given in Appendix B-2. This data summary shows that the average age of the participants was 41. All but two held the Ph.D. or Ed.D. degree. Most of the participants were from universities and 27 states were represented. The participants published an average of 15 research articles or technical reports. They are active in other professional organizations as indicated in their response to item 16.

It was evident in reading the reasons why many of the participants indicated a desire to attend a research training program that the interpretation of what constitutes research in science education varies enormously. Some participants indicated that they wished to attend to learn how research in science teaching could make them a better classroom teacher of biology or chemistry or some other subject. Some indicated a desire to acquire specific competencies normally presented in graduate training programs for research workers, for example, to learn more about statistical tools and their application to research in science education. While these goals may be laudable, it was doubtful that any of them could be met in a three day research training program. There was a close correlation between the objectives stated by those individuals selected for program participation and the research competencies we sought to develop in the training programs.

All participants selected attended the training sessions. In addition to 100% attendance, we found the participants to be almost without exception enthusiastic and active throughout the program. Their willingness to take three days from busy work schedules to attend sessions to improve their research competence is evidence that the program was needed and that similar training programs are likely to receive enthusiastic and productive response.

The Training Program Work Sessions

All participants were asked to select one of six Work Sessions prior to their arrival in Chicago. Materials prepared by the Work Session leaders were mailed to the participants in advance of the sessions. These materials appear in Appendix C-1. Reprints of research studies, mimeographed materials, and other special handouts were also distributed during the Work Sessions. The large bulk of these materials preclude inclusion in this report. However, a listing of many of the references used is given in Appendix C-2. In addition to material distributed, the large fund of experience in research brought to the training sessions by the Work Session leaders and by many of the participants contributed substantially to the work of the sessions.

The Work Session led by Professor Henry Walbesser of the University of Maryland used material developed by Professor Walbesser and selected research studies in the training of participants in specific research competencies. The Work Session dealt with the acquisition of a specified collection of twenty-three behaviors. Instructional materials were developed for each of the behaviors and assessment tasks, different from the instructional activities, were also constructed. The participants in this work group acquired the first 18 of the behaviors. There was not sufficient time to progress through the remaining five behaviors. The participants did acquire the specified research competencies as measured by the assessment tasks. Whether these were acquired in any broader context will need the passage of time and examination of research publications from the work group participants and the publications of the participants' students.

The Work Sessions led by Professor J. Myron Atkin of the University of Illinois departed from the pattern for other sessions and dealt with a number of issues involved in policy decisions in the establishment of research priorities and allocation of effort in other areas of education. This group used as a springboard for discussion a paper prepared by Professor Atkin, "Research Styles in Science Education," published in the Journal of Research in Science Teaching at an earlier date. Professor Atkin also presented a seminar on some of his ideas on Thursday morning. The latter seminar was attended by all participants in the training conference. A major argument of Professor Atkin is that the "systems" approach to education, or the application of engineering models to education, is inappropriate and can lead to unpredictable and unfortunate consequences. Research styles in education too often follow the pattern in the physical sciences with the evident but unstated assumption that this research methodology is appropriate to education and that instructional design can be approached in a quasi-systems manner. These Work Sessions and the subsequent involvement of the participants in Problem Sessions served as a stimulus for critical review of the application of research competencies provided to trainees in other Work Sessions.

The Work Sessions on curriculum evaluation strategies led by Professor Wayne Welch of the University of Minnesota utilized a number of published research reports, given in Appendix C-2 as well as other materials distributed at the sessions. Trainees were instructed in techniques for formative and summative evaluation. The formative evaluation program of the Ginn and Company Elementary Science course was used as one example of curriculum evaluation. The four year evaluation program for Harvard Project Physics was a primary reference source. Also used was the summative evaluation of the course, Physical Science for Non-Scientists (PSNS). In addition to critical review of the materials, participants were asked to criticize and evaluate selected aspects of the curriculum evaluation studies. The latter work indicated substantial progress in the group in their curriculum evaluation skills.

Utilizing portable video tape recordings, Professor John A. Easley of the University of Illinois led his Work Sessions in the clinical analysis of teacher and pupil behaviors in classrooms. Drawing from materials distributed to participants in advance, the trainees analyzed the behavior of teachers and pupils in the taped classroom behavior samples. These sessions provided an opportunity to acquire skills in the use of clinical observation techniques through their application in a sample of recorded sessions.

The sessions on the use of computers in science education research were led by Professor Duncan Hansen of the Florida State University. Each of the participants in this session focused on a problem related to the development of a new instructional subsystem utilizing a computer. Some of the participants related directly to research projects in which they are engaged or to new research topics which they considered feasible for their particular circumstance. Each of the participants gained sufficient understanding of the essential concepts involved in the psychology, direction, presentation, correction, and evaluation of materials in order to provide clarity to the case study project utilized in the training session. Each participant developed a research design in some cases hypothetical, that would provide an opportunity to assess rigorously the nature and merit of their proposed science instructional component utilizing computers. The participants reacted to the research literature review and established lines of communication for future exchange of ideas on the use of computers in their research.

The Work Sessions led by Professor Novak of Cornell University focused on the learning theory of Professor David Ausubel. Reviewing some of the major constructs of this theory, as presented in his book, Educational Psychology: A Cognitive View, the group proceeded to review selected research studies to determine what interpretation could be placed on the data if the learning theoretical model of Professor Ausubel were applied. Since most reported research in science education does not relate to any learning theoretical base, it is possible, though hazardous, to reinterpret data obtained in research and to test hypotheses that would derive from the learning theory through post-hoc interpretation of published data. The participants succeeded in acquiring the necessary knowledge and skill needed to reinterpret earlier studies and to assess their support or non-support of Ausubelian learning theory. The second and third Work Sessions focused on the design of new research studies that would be based on Ausubelian theory and contribute evidence relative to specific constructs in the theory. It was agreed that this type of focus in science education research studies could increase the generalizability of research findings and enhance their potential application to the design of science instruction.

It was the impression of the Work Session leaders, in a summary conference on Friday morning, that the trainees were highly cooperative and seriously involved in the sessions. This active participation by the trainees contributed substantially to the value of all the Work Sessions. Many of the individuals involved in the Work Sessions have had substantial experience in science education and brought this experience to bear on the development of the specific research competencies or on the issues of science education discussed in the Work Sessions.

Training Program Problem Sessions

The purpose of the Problem Sessions was to Provide a different mixing of participants from various Work Sessions where research skills obtained in the Work Sessions could be applied to specific problems in science education. Most of the Work Sessions operated quite formally with training procedures following almost a classroom routine. It was thought that the Problem Sessions thus would contribute some variety of pacing to the total training program. A number of problem areas were identified and participants were asked to indicate which sessions were of particular interest to them. They were also asked to suggest other problem areas which they would like to explore. A list of Problem Session participants and the chairmen for the Problem Session groups is given in Appendix D-1.

Nine Problem Session groups were formed, eached chaired by a participant selected for this role in advance of the meetings. In most cases, the chairmen were senior members of the science education community who have had experience in the area of the Problem Session. The intent was to provide a forum for discussion and analysis and not a series of lectures by individuals in the Problem Session groups. For the most part, our directive that the participants seek ways to apply skills they were obtaining in the Work Sessions to the topic of their Problem Session were followed. However, most trainees found it difficult to make specific, positive transfer from the Work Sessions to the Problem Sessions.

Problem Session A dealt with the design of research training programs. This group, chaired by Professor Fletcher Watson of Harvard University, identified three types of research studies and terminal competencies needed for these types of research. The intent was to provide some general framework for the the design of research training programs. The types of research and terminal behaviors suggested were as follows:

Fields	Terminal Behaviors
1. Hypothesis Testing	To construct research hypotheses, investigations
2. Evaluative Studies	To construct research question investigations for summative, formative and supportive studies
3. Conceptual Analysis	To construct analyses of assumptions and alternative decision-making strategies

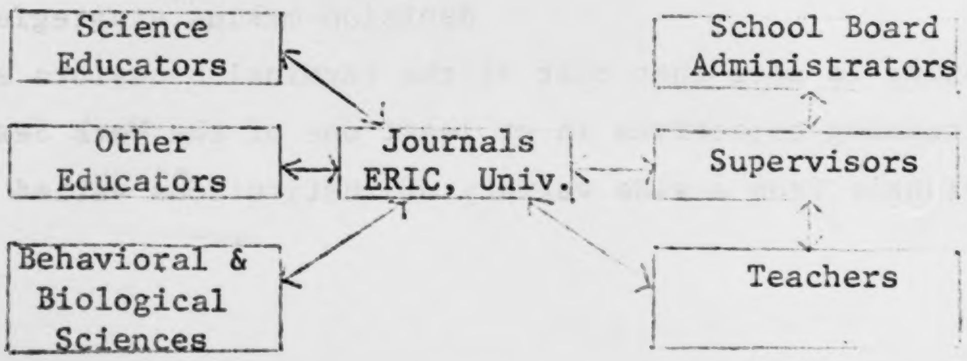
It is interesting to note that most of the terminal behaviors suggested were a portion of the training objectives in at least one of the Work Sessions. While the needs of individuals from a wide variety of institutions varied enormously, there seemed to be some consensus that the Problem Session discussions and explorations were helpful to the individuals in the local planning efforts they hope to make in designing research training programs.

The second Problem Session dealt with research and methodology involving audio-tutorial methods. Professor Samuel Postlethwait of Purdue University chaired some of the sessions for this group. Other sessions were chaired by other members of the group. The group discussed various forms of individualized instruction where audio-tutorial methods could contribute substantially. It was also agreed that the combination of audio-tutorial methods with other forms of individual activity and with computer assisted instruction could be fruitful. Several areas of research were identified. It was indicated that comparative studies of conventional versus audio-tutorial programs could contribute little of value. More importantly, questions regarding the process by which students arrive at specific competencies under the audio-tutorial regime were looked upon as more fruitful. Also needed, more research where learning theory is applied to the design of instruction and data on pupil attainment is taken as empirical corroboration of the theoretical premises. The need for comparing relative student achievement under various alternative instructional sequences in the audio-tutorial format was also identified. In the latter regard, the efficiency of pupil learning under various instructional sequences as measured by the amount of time required to reach specific competency levels was an important kind of research study needed.

Two of the initial Problem Sessions were combined to form one group dealing with issues involved in communicating and writing research. This group was co-chaired by Professor Stanley Helgeson of Ohio State University and Professor Herbert Smith of Colorado State University. The group identified a number of issues and problems in communicating and writing research. These were summarized by the group in the following way:

1. The following dimensions were identified as being substantive elements in communicating research:
    a. Target audience
    b. Purpose
    c. What
    d. How

    The dimensions were conceptualized in the model below:



2. The supervisor of science is a key individual in the dissemination of research and may function as a liaison between the research community and the educational practitioners--teachers, administrators.
3. An effort should be made to identify and encourage mission oriented research rather than the traditional view of individual efforts.
4. The following questions, which need further discussion and research, were generated:
   a. In the structure of administrative staff, who is the best target for conveying research? Is it the supervisor? In all cases? In what cases?
   b. Can we put research into a form for dissemination to schools, that its assimilation and continued communication can be enhanced? Who will be responsible for interpretation?
   c. Is there a preferred form for reporting research?
   d. Should universities develop care areas for research, i.e. be mission oriented?
   e. How can existing avenues, such as ERIC, be used more effectively?
   f. Does the vehicle stimulate practical use?

Another group of trainees dealt with problems of dissemination of curriculum information. This group was chaired by Professor David Lockard of the University of Maryland. This group was comprised of individuals involved in one way or another in the development of curriculum or in the dissemination of curriculum information. Their direct involvement in these areas was the primary basis on which they derived a summary form for the problem of curriculum dissemination. The following outline represents the organization of science education research topics identified as of contemporary significance. It was suggested that all are worthy of investigation.

I. Information distribution model
   A. Concise summary reporting of curriculum development at various levels:
      1. Local
      2. State or Regional
      3. National
      4. International
   B. Implementation reporting
      1. Methods of implementing projects
         a. Community involvement
         b. Local staff involvement
         c. Budgetary problems
         d. Selection procedures

II. Teacher preparation model
   A. Direct involvement with Project/University/Regional Lab
   B. Leadership conferences for teachers of teachers

III. Studies related to the dissemination role of:
   - A. Project-publishing house combines
   - B. Professional organizations
   - C. Parent organizations of sponsored projects
   - D. Professors of Science Teaching Methods
   - E. Professors of Science (subject matter)

Under the chairmanship of John Montean of the University of Rochester and Stephen Winter of the State University of New York at Buffalo, one group addressed itself to problems of research on teaching styles. The group suggested attention to the following characteristics of teaching style:

1. Teaching style is an important variable only because it has an influence on pupil growth.
2. Teaching style is the composite of teacher behavior in a variety of dimensions that can be individually measured:
   - a. Nature of content objectives
   - b. Affective, aesthetic, and other non-cognitive objectives
   - c. Tactics of teaching employed
   - d. Assumptions about learning
   - e. The learning environment
3. In research on style, attention should be given to style using tactics in new as well as conventional environments.
4. In the domains of style that can be measured by Flanders Interaction Analysis, research has begun to produce empirical evidence regarding the relationship between this domain of style and pupil learning. This research should be developed to the point that generalizations can serve as guides to teachers after self-analysis of performance. Additional research on style, likewise, should seek the goal of guidance to teacher performance.
5. The group recommends to the science education research community and NARST:
   - a. Publication of summary articles with critical analyses of the state of development of research and measurement tools in the dimensions of teaching style.
   - b. Organization of Symposia on Research in the dimensions of teaching style at national meetings
   - c. The incorporation of a Work Session on Flanders type instruments at the next NARST Research Training Conference
   - d. Additional Work Sessions to train for research on teaching style

Somewhat related to the work of the group focusing on problems of research on teaching style was the work on research on teacher characteristics. This group was chaired by Professor Willard Jacobson of Columbia University and Professor Wayne Taylor of Michigan State University. During these Problem Sessions, the trainees discussed various issues involved in research on teacher characteristics. The following problems were identified as important:

1. How can we make certain that the research problems that we identify are significant in the social context of our times?
2. Who stays in elementary school teaching and who doesn't? In particular, what are the characteristics of those who drop out? What are the characteristics of teacher education programs whose graduates tend to stay in teaching?
3. What are the distinguishing characteristics of teachers that tend to be successful with regard to the various criterion measures we use?
4. What kinds of institutional settings are conducive to research? Are there ways that researchers who have heavy teaching and administrative loads can still do research?
5. What personal characteristics of teachers can actually be changed? What are some successful approaches for changing such characteristics?
6. How can changes in teaching styles be accomplished in academic year institutes?
7. How can we replicate studies so that we can generalize from them?
8. How can various media be used most effectively in teacher education?
9. Should we have programmed research efforts? Or, should each researcher take on the responsibility of identifying the problems that he thinks are most significant? What is the appropriate mix of these two approaches?
10. What are the characteristics of teachers who are most successful in difficult urban school settings?
11. Can we compile a list of research instruments available for use by science education researchers?

A group of trainees under the chairmanship of Professor Robert Buell of the University of Toledo directed their attention to the role of inquiry in teaching. This group set forth a number of assumptions regarding inquiry teaching and then identified clusters of questions that can be researched. These were as follows:

Assumptions

1. Inquiry is a set of processes applied to a conceptual framework of a knowledge.
2. In inquiry teaching, teachers provide students with the opportunity to structure their own knowledge.
3. Inquiry involves certain identifiable process skills by which knowledge is formulated.
4. Inquiry teaching will provide learners with skills and behaviors that are both of broad applicability, and of long tenure in a rapidly changing culture.
5. The teacher as inquirer behaves differently from the teacher as purveyor.

Inquiry teaching, as defined by our task force, consists of those teaching behaviors which help learners develop a propensity for and skills in:

a. asking questions about the natural world,
b. gathering information relevant to these questions, and
c. organizing and assimilating this information.

Two varieties of inquiry teaching are presently extant. In one of these, which we called unstructured inquiry teaching, students inquire freely, formulating their own questions, gathering information and making interpretations on their own. The other main variety we called structured inquiry teaching. In this considerable guidance is given to the students as they inquire, usually by stating the questions about which they are to gather information and then make interpretations. Although there are many mutations of each, these two main forms reasonably describe the inquiry teaching formats.

A universe of research questions can be raised relevant to inquiry teaching. Below a few constellations of research questions are pointed at, and some specific exemplars are given.

Questions relating to students

1. What learning outcomes emerge from unstructured inquiry teaching? What learning outcomes emerge from structured inquiry teaching?
2. Can students' questioning behaviors be attributed to modeling the teacher's questioning behaviors? Does this vary if teaching is done by machine?
3. What are the characteristics of questions asked by students in an unstructured inquiry teaching situation?
4. In what ways do personality, intelligence, prior experience in inquiry situations and school achievement influence students' responsiveness in structured and unstructured inquiry teaching situations?
5. What impact does training in specific inquiry skills have on students' ability to carry on unstructured inquiry? to carry on structured inquiry?
6. To what extent can children be trained in the strategies of inquiry? To what extent must children discover their own personalized strategies of inquiry?
7. How can researchers assess students' ability to
    a. ask researchable questions,
    b. collect information relevant to these questions,
    c. make interpretations of this information?
8. How can reliable, valid instruments be developed to measure students' inquiry capabilities?
9. What experiences will enhance students' propensity to "transfer" inquiry skills?
10. Can personality characteristics of children be identified that influence inquiry, teaching behavior?

Questions relating to teachers' personal characteristics

1. Can personality characteristics of teachers be identified that influence inquiry teaching behavior?
2. What personality variables of teachers enhance or detract from inquiry teaching?

3. What social cultural factors in teachers' backgrounds, and what differences between students and teachers may influence inquiry teaching behavior and outcomes?

Questions relating to teacher training variables

1. In what ways can prospective teachers' role expectations be changed to better prepare them for inquiry teaching?
2. How can the "modeling" effect of 16 or more years of didactic teaching be overcome to prepare prospective teachers for inquiry teaching?
3. Does inquiry teaching consist of isolable behaviors which can be identified and for which prospective teachers can be trained? How can this training be accomplished?
4. Can teacher behaviors be identified that are related to students' success in inquiry?

Questions relating to organizational variables

1. Do teams of teachers tend to sustain inquiry teaching behaviors more readily than isolated teachers?
2. What reward systems will be necessary to sustain teachers' adaptation from a didactic to an inquiry teaching model?
3. What possible organizational restructurings might stimulate teacher-pupil interaction or interactions between teachers with a resultant enhancement of inquiry teaching?

There were a group of participants who indicated special interest in topics other than those suggested to the trainees. These individuals formed a group which we labeled Special Topics. This group proved to be heterogeneous in interests, but nevertheless they did succeed in identifying a number of researchable areas that included their areas of interest. The following suggestions were included in the report from this group:

1. What are the characteristics of school pupils who
   a. reject the opportunity to learn?
   b. accept the opportunity to learn?
2. What differences exist between the teachers' and children's perception of science class tasks? How can these be detected, described, evaluated?
3. What are the possibilities in the use of "unobtrusive" measures as research techniques in evaluation of science education conditions and practices?
4. How can science education be studied in its ecological realm - the community, building, location and relationship with respect to other disciplines?
5. There is need for research in the development and use of a variety of measures on students regarding:
   a. Their rationality as they enter society.

        1) The kinds of arguments they use in support of actions.
        2) How much use, through application and reference, they make of empirical findings.
        3) How much and in what ways they are reactive to their environment.
    b. Their understanding of science and technology as social activities.
        1) Are their expectations realistic?
        2) Do they understand the constraints placed on science and scientists?
    c. Their understanding of their environment.
        1) Are their expectations of the natural world realistic?
6. There is need for the development of a vocabulary based on evidence about teacher behaviors, techniques, etc., similar to that which arises from test scores descriptive of certain student characteristics - a vocabulary which would make possible the sharing of what teachers are doing in their classrooms and why they operate in this manner.

It is evident from the foregoing that the Problem Sessions were not research training sessions in the formal sense. Nevertheless, skills are of little value until they can be applied to problems where fruitful results can emerge. Though the style of the Problem Sessions was informal and bordered at times on the fringe of dubious "bull sessions," the summary reports from the groups suggested that considerable value did emerge from these Problem Sessions. This was also borne out by the evaluation reported below.

Evaluation

The evaluation for each of the work sessions was conducted by the Work Session leader. The objective of the evaluation was to assess the degree to which the program training objectives were achieved. They also served the purpose of providing information to the session leaders and to the Program Director on which recommendations for the design of future research training programs could be based.

In the Work Sessions led by Professor Walbesser, a specific set of objectives were established. A list of objectives and the assessment tasks for these objectives is given in Appendix E-1. It was possible to review the assessment tasks and to determine the success of this portion of the training program. Walbesser reported that all trainees succeeded in acquiring the first eighteen competencies. Time did not permit completion of the remaining training materials and assessment tasks. It was Professor Walbesser's appraisal that the participants did acquire the specified research competences measured by the assessment tasks utilized.

The Sessions conducted by Dean J. Myron Atkin were substantially different than the other five Work Sessions. There was no attempt to train participants in specific research competencies but rather to look at broader issues affecting the science education research community. The Work Sessions dealing with policy for science education research and science education in general discussed the problem of increasing the influence of the science education research community in national councils where policy is ultimately made.

The Work Session dealing with policy for science education research and science education in general discussed the problem of increasing the influence of the science education research community in national councils where policy is ultimately made. A communications gap was identified which, it was suggested, could be traced in part to a lack of external credibility of the research of science educators.

The credibility gap, it was agreed, has roots in the inability of science educators to make their research relevant to curriculum directors and others who cope with science education problems "in the real world". Among the problems seemed to be fragmented studies, restricted categories of research, lack of programmatic studies, lack of communication among investigators at different institutions. Among solutions suggested was institutional specialization in research.

Regarding the restriction on styles of research, it was agreed that to make research in science education useful to the schools, the question and its appropriateness not the style must be the guide. The purpose for influencing teaching and the possibility of using the findings in schools are the determining factors in judging the value of a study, not its adherence to some hypothetical model of "good" research.

As examples of important school needs not adequately met by current activities of the science education research community are interpretations of findings that can be read by teachers and supervisors and that consider the conditions of pupils and teachers in schools, broader attention to the concerns of practicing teachers, and other involvement with school conditions.

The group also discussed the importance of developing the base data and hypothetical projections for questions of science education policy. It was recognized that national policy is legitimately developed by inputs from many different groups and that our influence can only be as great as the quality of our advice.

The group appreciated this opportunity to discuss, for a relatively protracted period of time, questions of formulation of science education policy. In the opinion of the participants these questions deserve top priority and this conference provided a timely opportunity to consider them at length.

The Work Sessions dealing with curriculum evaluation strategies was led by Professor Wayne Welch. The attempt to present methods for attaching questions of curriculum evaluation were successful in the opinion of the Work Session leader. Individual participants commented on their own experiences in the sessions and some of the partial quotations from their reports are as follows:

> "The Work Session on curriculum evaluation has been exceedingly stimulating and helpful primarily due to the expertise and extensive preparation that Dr. Welch brought to the Session."
>
> "This Work Session was the most rewarding part of the training program. The practice of providing us a series of papers, instruments, and strategies for curriculum evaluation was most appropriate for a conference of this length. For my particular purpose this type of training was very helpful. I commend this procedure for future use."
>
> "I will return home with a substantial number of relevant and useable papers, ideas for research problems and a number of new and potentially productive contacts with innovators in the field--the latter being what I consider my most valuable acquisition from the program."
>
> "The Sessions brought together into sharp focus problems, techniques, resources, references, and experiences which would have taken months for an individual working by himself to arrive at, discover, ferret out or obtain."

These quotations indicate that the kind of skills being presented and the evaluation work done in this series of Work Sessions was valuable to the trainees.

The Work Sessions dealing with conceptual analysis of classroom behaviors was led by Professor John Easley. During the first session the participants viewed two tapes dealing with PSSC materials. Participants learned that conceptual analysis of classroom interviews is closer to formative than summative evaluation, but is perhaps most effective if it precedes new curriculum planning because of the surprising new entry points it suggests for instruction in the given subject. The participants learned that children react differently to different interviewers and learn the value of videotape in permitting analysis of the behaviour observed. Some of the competencies required included a technique for evaluating children's performance via video tape, evaluation techniques associated with audio-tutorial instruction, methods for identifying defects in teacher education programs and clues to the improvement of these programs. The use of the techniques presented in these Work Sessions also suggested a number of new research possibilities to the participants.

The Work Sessions led by Professor Duncan Hansen dealt with the use of computers in science education research. The intent was to provide participants with information and new contents regarding the role of computers in science research and curriculum planning. The evaluation forms of participants in these Work Sessions indicated that they acquired competencies in understanding general techniques for programming CAI with respect to whole course and part course materials, including writing and evaluating global and detailed behavioral objectives. An understanding of the contrast between Ausubelian and Piagetian models of development and cognitive growth and appropriate research techniques for within and between model testing were acquired. An extension of "inquiry skill" in research with CAI and CMI models was provided. Participants learned to discern researchable areas in teacher characteristics and teaching style using computer mediated approaches. A further evidence of the value of these Work Sessions was indicated in that half of the participants planned a continuing dialogue on some of the topics presented in the Work Sessions with Professor Hansen.

In the Work Sessions led by Professor Joseph Novak, the objective was to present enough of the nature of David Ausubel's learning theory that this could be utilized in the analysis of research studies and in the design of new research. Selected published research was distributed to the participants and each participant was asked to interpret portions of the research in terms of constructs in Ausubel's learning theory. Though the time available in the sessions was relatively brief, at least one trainee could state in his summary report on the training sessions, "I was introduced to a specific theory of learning and became well enough acquainted with the theory to apply it to research design and analysis. I had practice in conversing within the 'framework' of the theory and also had practice in analysis in terms of this learning theory. I was also stimulated to start making preliminary research designs using this theory." Comments by others support this appraisal.

The evaluations of the Work Session leaders as well as the evaluations presented at the summary sessions on Friday, indicated that the Work Sessions did succeed in developing research competencies and related skills by most if not all of the participants. It was difficult to get both trainees and many of the leadership personnel to be highly specific in their appraisal of the skills and competencies achieved during the training sessions. Partly for this reason a questionnaire was mailed to all participants immediately following the training sessions. This questionnaire contained four items.

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:
2. The most valuable part of the program for me was:
3. The least valuable part of the program was (provide reasons for your answer, if possible):
4. Participants I would recommend for leadership roles in future training programs are:

Most of the questionnaires were returned promptly by the participants. With some follow up correspondence all participants returned questionnaire forms. Copies of these are included in Appendix E-2.

The responses to the first question on the questionnaire varied widely depending on the Work Sessions that the participants engaged in. In general, almost all participants were able to identify specific research competencies and skills that they obtained in the Work Sessions. The response of some participants was highly specific and indicated clearly the competency gained. A few respondents could not identify new competencies that they gained, which might be partly an indication that the heterogeneity of the group was too great for the type of program planned.

The responses to question two on the questionnaire indicated that the most valuable part of the program was the Work Sessions. Equally important was an opportunity for informal discussion and exchange of ideas with colleagues. Many participants found value in the Problem Sessions, but the responses to question three indicated that at least some of the Problem Sessions were not productive and could have been eliminated. The weakest portion of the program apparently was the brief presentation by each of the Work Session leaders on Wednesday. These presentations did not provide sufficient depth in the subject to be covered in the Work Sessions to be of value to the participants and should be eliminated in future training programs.

In general, the evaluation forms indicate that increasing the homogeneity of the trainees would improve the quality of the training program. Also, more emphasis should be placed on intensive training in work in sessions similar to the Work Sessions. Although a number of participants found the Problem Sessions valuable, many suggested that the kinds of issues presented in Problem Sessions should be discussed informally during luncheons or in evenings. It is the Director's evaluation that the Training Program could be shortened to two intensive days of training similar to that in the Work Sessions. Evening hours could remain free for informal discussions, although provisions should be made for meeting rooms where trainees can associate to discuss issues of interest to them.

The support facilities that were made available in the form of secretarial assistance and ditto duplication were of some value to the conduct of the sessions. However, materials tended to come in on very short notice and in quantities too large for two secretaries to handle. At other times, the secretaries found themselves without work. It might be more desirable to arrange for xerox facilities where hand written materials could be copied immediately and not require typing on to ditto masters.

Participants in the Training Program were complimentary regarding the overall physical arrangements at the Hotel and procedures established to provide travel and living reimbursement by the afternoon of the last training day. In the Director's opinion a fine esprit de corps existed among the group, indicating that participants were generally satisfied with the experience and would be interested in further participation in training programs of this type. Suggestions for new leadership personnel were provided by the trainees in response to item four on the questionnaire form. It is hoped that NARST can sponsor training programs for research workers in science education on an annual or biannual basis.

Appendix

A-1. NARST Tentative Program

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

1969 RESEARCH TRAINING SESSIONS

INFORMATION & APPLICATION FORM

A grant from the Training Research Branch of the U.S. Office of Education will make it possible for NARST to conduct a research training session during November, 1969. The sessions will be held in Chicago during November.

TENTATIVE PROGRAM OUTLINE
for a
RESEARCH TRAINING PROJECT IN SCIENCE EDUCATION
Chicago, Illinois, November 12-14, 1969

Session I. Wednesday, November 12, 1969, 9:00 A.M.
Chairman: Willard Jacobson
Topic: Translating learning theory into research hypotheses in science education
Speakers: John A. Easley, University of Illinois
Joseph D. Novak, Cornell University
Work Sessions

Session II. Wednesday, 2:00 P.M. — Continue Session I.

Session III. Thursday, November 13, 9:00 A.M.
Chairman: Clarence Boeck
Topic: Identification of techniques and skills needed by science education researchers
Speaker: Henry Walbesser, University of Maryland
Work Sessions
Topic: Experimental and Evaluative Designs
Speaker: Jack Merwin, University of Minnesota
Work Sessions

Session IV. Thursday, 2:00 P.M.
Chairman: T. Wayne Taylor
Topic: Promising Research Directions in Science Education
Speaker: J. Myron Atkin, University of Illinois
Work Sessions

Session V. Friday, November 14, 9:00 A.M.
Chairman: Darrel Barnard
Topic: Technology and science education research design

1. CAI and research — Duncan Hansen
2. Evaluation of learning aids — Wayne Welch
3. Audio-tutorial techniques and research — Samuel Postlethwait

Evaluation sessions will follow each presenter.

Session VI. Friday, 2:00 P.M.
Chairman: James Robinson
Final evaluation and summary sessions:

1. Selection of research workers — Frederic Dutton
2. Resources for research training — Richard Harbeck
3. Changes needed in university programs — Fletcher Watson
4. Research design and data analysis — William Cooley

Participation in the NARST 1969 Research Training Session is not restricted to NARST MEMBERS. The program is intended for persons who are engaged full or part-time in the conduct of science education research activities. Neither fees nor tuition is charged for any of the sessions. Travel allowance and per diem allowances will be provided.

Applications will be processed in the order they are received. Applicants are encouraged to apply early since the program is limited to 50 participants. Most applicants may expect to be notified of the decision of the selection committee within three weeks after the receipt of their application.

Return to: Prof. J. D. Novak
Division of Science Education
Stone Hall
Cornell University
Ithaca, N. Y. 14850

Application For NARST Research Training Session

GENERAL INFORMATION

1. Name: ______________________________
Last First Initial

2. Mailing address: ______________________________

3. Sex: M F Age: ________ Telephone No.: ______________

4. Present Institutional Affiliation (e.g., UCLA): ______________________________

5. Have you attended an AERA training session in the past? Yes No
If "Yes," when: ____________ and which one: ______________

EDUCATIONAL HISTORY

7a. Masters School: __________ Year of Degree ____
Major ______________

b. Doctoral School: __________ Year of Degree ____
Major ______________

8a. Record in the blank the approximate number of **courses** you have taken at either the **undergraduate** or **graduate** level in each of the following areas:

a. Anthropology
b. Biology
c. Chemistry
d. Curriculum
e. Earth Sciences
f. Educ. Measurement or Psychometrics
g. Electronic Computers
h. Linguistics
i. Mathematics (excluding math educ.)
j. Physics
k. Psychology (Exper., Soc., Devel., or Learning)
l. Sociology
m. Statistics and experimental design

EMPLOYMENT INFORMATION

9a. Describe briefly the nature of your present employment: ______________________________

b. Describe briefly any changes you expect in your employment during the coming year with respect to either employer or type of activity: ______________________________

10a. What percent of your time is allotted to teaching? ______ b. To research? ______ c. To grad. study? ______

11. Which courses do you teach (if any), at what level (undergraduate__U.G.__or graduate__G), and what textbook (if any) might you typically use?

Course	Level	Textbook
	U.G.______ G.______	
	U.G.______ G.______	
	U.G.______ G.______	
	U.G.______ G.______	

PROFESSIONAL AND SCHOLARLY INTERESTS

12. What are your primary research interests? ______________________________

13. Approximately how many research articles which you have authored alone or jointly have been accepted in a scholarly (refereed) journal? ______

14. In total, about how many research articles, theses or technical reports (both published and unpublished) have you authored alone or jointly? ______

15. How many funded (by USOE, NIMH, NSF, Ford Foundation, or other granting agencies) research projects are in progress or completed on which your name appears as either the first or a joint author? ______

16. List no more than three professional societies. ______________________________

17. Describe briefly your reason for applying.
(use separate sheet)

Appendix

A-2. NARST Program

NARST RESEARCH TRAINING SESSION

Chicago, Illinois

November 12-14, 1969

Wednesday, November 12	Thursday, November 13	Friday, November 14
9:00 A.M. Welcome: Willard Jacobson 1. Henry Walbesser, University of Maryland 2. J. Myron Atkin, University of Illinois 3. Wayne Welch, University of Minnesota	9:00 A.M. J. Myron Atkin	9:00 A.M. Work Sessions
10:30 A.M. Organize Problem Groups	Panel and Audience Participation	Problem Sessions
	Problem Sessions	
12:30 Lunch	12:30 Lunch	12:30 Lunch
2:00 P.M. 4. John A. Easley, University of Illinois 5. Duncan Hansen, Florida State University 6. Joseph D. Novak, Cornell University	2:00 P.M. Work Sessions	2:00 P.M. Problem and Work Reports
3:00 P.M. Work Sessions		Presentation of Problem Areas and Closing Summary
	Cocktail Hour	

Appendix

B-1. List of Participants

NARST Research Training Program

Work Session Leaders

Atkin, J. Myron	University of Illinois
Easley, John A.	University of Illinois
Hansen, Duncan	Florida State University
Novak, Joseph D.	Cornell University
Walbesser, Henry	University of Maryland
Welch, Wayne	University of Minnesota

Participants

Anderson, Harold M.	University of Colorado
Arnold, Daniel S.	University of Kentucky
Awkerman, Gary L.	Charleston, S.C. County Schools
Berryman, William C.	Sylacauga, Alabama Schools
Bingman, Richard M.	McREL, Kansas City, Missouri
Boeck, Clarence H.	University of Minnesota
Boener, Charlotte M.	Indiana State University
Bowles, Joseph E.	University of South Carolina
Bridgham, Robert G.	Stanford University
Buell, Robert R.	University of Toledo
Butts, David P.	University of Texas
Cleaver, Thomas J.	University of Colorado
Doran, Rodney L.	State University of New York at Buffalo
Dyrli, Odvard E.	University of Connecticut
Fitzgibbon, Robert	Greece Central Schools, Rochester, N.Y.
Fowler, H. Seymour	Pennsylvania State University
Gallagher, James J.	Educational Research Council, Cleveland
Hanson, Robert W.	University of Northern Iowa
* Harbeck, Richard M.	U.S. Office of Education, Washington, D.C.
Hassard, John R.	Georgia State University
Hein, Harold C.	University of Mississippi
Helgeson, Stanley	Ohio State University
Jacobson, Willard	Columbia University
James, Robert K.	Kansas State University
Jerkins, Kenneth	Morgan State College
Koutnik, Paul G.	McREL, Kansas City, Missouri
LaShier, William S.	Kansas State Teachers College
Lockard, J. David	University of Maryland

McCurdy, Donald W.	University of Nebraska
Menefee, Robert W.	University of Maryland
Merkle, Dale G.	Shippensburg State College
Montean, John J.	University of Rochester
Myers, Gerald A.	South Dakota State University
Nelson, Clarence	Michigan State University
Novick, Seymour	Temple University
Olstad, Roger G.	University of Washington
Oshima, Eugene A.	Central Missouri State College
Pella, Milton O.	University of Wisconsin
Postlethwait, Samuel	Purdue University
Schaff, John F.	Syracuse University
Schirner, Silas W.	University of Houston
Schmidt, Donald J.	Fitchburg State College
Schmuckler, Joseph S.	Temple University
Smith, Herbert A.	Colorado State University
Taylor, Wayne	Michigan State University
Trent, John H.	University of Nevada at Reno
Tweeten, Paul W.	University of New Mexico
Uffelman, Robert L.	University of Delaware
Voelker, Alan M.	University of Wisconsin
Watson, Fletcher	Harvard University
Winter, Stephen	State University of New York at Buffalo
Wood, Roger L.	Wisconsin State University
Yager, Robert E.	University of Iowa

* U.S. Office of Education Observer

Appendix

B-2. Data Summary

DATA SUMMARY

A. Applications
   1. Requested 735
   2. Returned 309

B. Applicants
   1. Male 268, Female 41
   2. Average Age 37
   3. States Represented 41
   4. Highest degree: B.S. 18, M.A. or M.S. 166, Ed.D. or Ph.D. 125
   5. Prior attendance at a research training session: yes 7, no 302

C. Participants
   1. Male 49, Female 1
   2. Average Age 41
   3. States Represented 27
   4. Highest degree: B.S. 0, M.A. or M.S. 1, Ed.D. or Ph.D. 49
      a. Average year that highest degree was awarded: 1962
      b. Major subject:
         1) Astronomy 1
         2) Biology 1
         3) Biology-Science Education 2
         4) Botany 1
         5) Chemistry 1
         6) Curriculum & Instruction 5
         7) Education 1
         8) Geology-Science Education 1
         9) Plant Physiology & Plant Science 3
         10) Science Education 31
         11) Secondary Education 2
         12) Teacher Education 1
   5. Prior attendance at a research training session: yes 5, no 45
   6. Present employment:
      a. College and university professors 42
      b. Researchers in institutions engaged in educational research 5
      c. Directors of science, curriculum and instruction in public schools 3
   7. Anticipated changes in employment:
      a. No major changes 32
      b. More research involvement 12
      c. Seeking new positions offering increased research opportunities 2
      d. In process of defining newly created position 1
      e. More administrative duties 3
   8. Per cent of time allotted to:
      a. teaching 47
      b. research 33
      c. graduate study 6
      d. other (primarily administrative duties) 14

9. Nature of courses taught by those in colleges and universities (% in each category)

a. Methods and other science education courses	66
b. Research training	12
c. Science (e.g. botany)	11
d. Curriculum, learning theory, general education courses	11

10. Primary research interests:
    - a. Attitudes, and confidence in teaching; of non-science majors toward science; changes; impact of knowledge on attitudes; student attitudes toward science
    - b. Instruction, comparison of methods; design, evaluation and use of methods and materials of instruction
    - c. Evaluation, of achievement; learning aids; media; student teaching; teacher competencies. Construction of evaluation instruments
    - d. Cognitive development and learning theory
    - e. Curriculum development and evaluation
    - f. Teachers, role expectations; education; behavior; characteristics; effectiveness; competence; personality, change.
    - g. Studies in biology or conservation
11. Average number of research articles and technical reports authored by participants either alone or jointly: 15
12. Some reasons for applying:
    - a. To become familiar with current content, methodology and emphases in science education.
    - b. To update and improve research techniques and skills in order to improve the quality of research.
    - c. To interact with others doing research in science education.
    - d. To be better prepared to supervise doctoral students or others doing research.

Appendix

C-1. Work Session Materials

Some Exerpts from Writings

John A. Easley

University of Illinois

The Need for Conceptual Analysis in Science Education

Scientists are accused frequently these days of being unable (or unwilling to communicate their technical knowledge to the public effectively, in a time when technical information carries a heavier and heavier burden foreboding doom for both natural wilderness and civilization alike. Scientists whose biases are showing may well be the hottest commodity on the consultant market. The public is becoming increasingly aware that any given data can be variously interpreted by scientists of different persuasions, building an attitude which threatens the scientific establishment with a widening credibility gap. Even science teachers and science educators are saying, "We can't teach facts because, whatever we teach may well be changed in another decade." What is desperately needed is an understanding of the way differences in conceptual frameworks and social value systems can generate controversy in science without undermining the values of honest reporting and criticism which give the scientific profession its growth potential and therefore its value to society.

Science educators should, in my opinion, be investigating this problem as it expresses itself in science classrooms and should neither attempt to argue it away by dogmatic statements about the nature of science nor sit aback and wait for philosophers to figure out the answer. Who knows, perhaps a more realistic confrontation with the human phenomenon of misunderstanding science would help philosophers in theory building.

That the value of open criticism as a way of advancing knowledge is poorly understood by the public at large is evidenced by the unwillingness most people show to engage in public controversy or to admit that they may be in need of more exposure to information and argument. We do our "town meeting" vicariously by watching TV and reading letters to the editor. There is little guarantee in all this that the values of open criticism which advance scholarship can be adequately realized in a society where decisions are based on testimonials.

Science classes, which could do much to uphold the ideal of open debate, often succeed in surpressing debate by the allegedly scientific challenge, "How can you collect evidence to find out if you are right?" This question too often leads to innumerable experiments which are often undoable. Science teachers can ill afford to encourage their students to put forth their own ideas, if they must take the time to try to resolve every issue raised in this way by the collection of decisive evidence. Yet, without the freedom for students to attempt explanations of phenomena, which they have observed in terms of their own preconceptions, how can teachers persuade them of what they know except by appeal to authoritative opinion?

But besides the public good there is a more direct value in this sort of study. Evidence that is convincing to a scientist who is familiar with possible alternatives, and the evidence against them, may not be, and ordinarily should not be expected to be, convincing to a student who is just beginning to study the phenomena in question. There is a great need to find out what students typically think about phenomena before teachers and curriculum developers decide on the particular experiences and theory to be presented in science classes.

Still a third reason for study of student arguments and theory is to acquaint prospective science teachers with typical cases of what they will confront. They need to be prepared both for the specific theories which students typically hold and the style of argument and manner of evidence which students judge relevant to their beliefs. By presenting the standard evidence as though to convince students of a standard conclusion, we are often attempting to convince students of the value of evidence. However, if they do not already believe in the value of evidence, will they find the evidence convincing? One typically assumes either (1) that students already believe in the conclusions that scientists draw (and thus that they are learning about the criteria of confirmation) or (2) that they already have our criteria for judging the adequacy of evidence. But what we ought to expect is that they have neither, but they might have conclusions and criteria of their own.

A fourth reason for research into students thinking about their world--science, in other words--is to develop more useful diagnostic instruments and procedures for evaluation of student understanding. We must learn to count it a failure when physics students genuinely accept neither Newtonian mechanics, nor Einstein's ideas of general relativity, though they demonstrate ability to solve problems and judge that the evidence and the theories are not discrepant. When students persist in their own quasi-Aristotelian theory of motion, on the view that theories come and go and therefore they have as much right to an opinion on what makes things move as the next man, we have failed to communicate a modern method of scientific reasoning. But our tests are passed quite satisfactorily.

The point is that students have the right to be convinced by evidence and argument, but teachers have no right to drop their effort if the standard evidence and argument is unconvincing to their students. Putting it differently, research is needed into what the cognitive entry behavior of science students is. Knowing whether or not they have a desired piece of terminal behavior on entry is doubtless useful but clearly insufficient to plan instruction that will connect new experiences with present concepts, beliefs, and styles of evidence and argument.

Philosophical analysis, in which concepts and presuppositions of arguments are constructed to explain a widespread opinion in science or in philosophy, can in principle be practiced in the classroom as well as in the study or library. However, widespread employment of philosophically trained analysts as school teachers is not likely to happen in the near future. By making and analyzing video-tapes of interviews with children or classroom discussions, however, it should be possible to determine typical student preconceptions in a particular science course and design curriculum and instruction to relate to them.

We can gain a good deal of inspiration for research in this direction by examining the work of Jean Piaget and his associates. Even though one may legitimately quarrel with the boldness of his leaps from a few protocols to conclusions about the development of cognitive structure, one cannot so easily escape the evidence that children do develop convictions in very unorthodox ways, that these are regularities in their ways of thinking, and that interviewing children is going to tell us more about these phenomena than testing them or putting them through programmed instruction.

References:

Easley, J. A., Jr. (1958), "PSSC and Educational Theory," *Harvard Educational Review*.

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Piaget, Jean (1929, 1960), *The Child's Conception of the World*, Littlefield Adams Co. (paper). (The Introduction contains an excellent discussion of the clinical interview and its advantages over testing and experimentation.)

White, Morton (1955), *The Age of Analysis*, Mentor Books.

Witz, Klaus G. (1969a), "On Piaget's Grouping I," University of Illinois Curriculum Laboratory Working Paper, No. 13.

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CONCERNING EDUCATIONAL APPLICATIONS OF PIAGET THEORY

The possibility of an educational psychology that would guide instructional practice has long been discussed, but the guidance accomplished so far has been largely in such peripheral areas as classroom management and counseling students with learning difficulties. Little has been learned that relates directly to the organization of instruction in terms of its subject matter. Cognitive psychology has touched on aspects of this Ausubel (1968) but a theory of cognitive development so structural that it could be usefully applied to the precise guidance of instruction in mathematics and the sciences, for example, has not yet emerged. Piaget's work comes the closest of any to making contact with highly structured forms of knowledge, but his theory has lacked a clear enough formulation to permit operational testing in detail. A proposed method of analysis, developed by Witz, would solve some of the major problems in methodology which Piaget and his colleagues have side stepped in their creative theory development. Therefore this method promises much greater applicability to the design of curriculum and to the training of teachers in science and math than anything else that has been available from psychology.

The major point of discussion between curriculum developers and Piagetian theorists seems to have centered on the limitations that Piaget's findings allegedly place on the possibility of accelerating children's development through the stages of cognitive development (Ripple and Rockcastle, 1964), but closer examination of Piaget theory indicates that a more positive contribution to education is possible. To challenge these alleged rate limitations because the evidence is inconclusive (Cambridge Conference on School Mathematics, 1963) may have led to setting overly optimistic instructional goals, or it may have involved a misinterpretation of the structural aspects of the cognitive behavior which Piaget describes. (See Easley, 1964, for a discussion of this question.) Recognition of the limitations of growth rate has been turned to advantage by workers in several curriculum projects and in many British Infant Schools by providing opportunities for greater pupil initiative and for learning through manipulation of concrete objects.

Another approach to educational applications has been that of placing curriculum material so as to conform to the structural properties of Piaget's developmental stages (see, for example, the Macmillan elementary school science series). This approach to application is complicated by the fact that rather striking differences in development occur within the space of a few months and children within an otherwise homogeneous group show marked differences in cognitive development. Above all, it is complicated by ambiguities in Piaget theory. There is increasingly evident confusion concerning what constitutes a performance at the concrete--or at the formal--operational level, in logical or in mathematical problem solving typically required in schools.

The current pressure to formulate instructional objectives behaviorally, which has become a major feature of several curriculum projects attempting to individualize instruction, begs the difficult question of how such objectives are to be decided upon. Whatever merits may lie in this approach are unlikely to be realized unless cognitive structures involved in given tasks and the processes whereby children acquire particular intellectual abilities can be formalized. Thus, a test of this position could be enhanced by an improved Piagetian analysis. However, the implementation of precise instructional goals by means of the careful design of instructional materials--even putting them into programmed form--may be effectively limited by the social interactions between teachers and pupils, as has been demonstrated with programmed booklets merely handed out to pupils by their teachers. What is required is an understanding of the process whereby a child copes with the school environment, which includes the teacher, other pupils, and instructional materials.

If the influence of the school environment and teacher on a child's behavior are sharply reduced or controlled, as in Piaget interviews, it is often found that most children are ahead of the classroom demands in terms of basic intellectual skills, but receiving little or no help in applying them in the classroom (UMIST, 1969a, b, c). The curriculum is typically designed to move gradually from a simple, one- or two-variable analysis of phenomena through formal methods like arithmetic, graphing, or algebra, to more abstract and complex analyses, but the child often has leaped intuitively to the more powerful abstract level of theorizing which is difficult for him to formalize or operationalize. One can predict that he will consequently be rather discouraged at the slow progress of formal instruction and bewildered at what often must appear as an arbitrary adoption of formal definitions, methods, and measurement operation in the name of scientific inquiry.

To be sure, the processes to which the child is being introduced may be authentic and recognized as the most appropriate for advancing man's knowledge of natural phenomena. However, the child who, for example, has already organized his experiences with mechanical phenomena may feel quite confident in his understanding of objects in motion or static equilibrium of forces at an abstract level, simply because he has gained a great deal of control over his bodily actions in running, jumping, swinging, seesawing, bicycling, etc. If he regularly employs dynamical concepts which are more abstract and less operational than the curriculum allows, he will lack intrinsic motivation to undertake the fundamentals of measurement and kinematical description. Moreover, the processes of inquiry judged most appropriate for physics, chemistry, biology, etc., today may not be so appropriate tomorrow nor at all appropriate in new fields of investigation like ethology, genetic epistemology, and classroom interaction. Here, greater reliance on intuitive methods may be necessary, since, without a considerable intuitive knowledge of a phenomenon, it is very unclear as to what should be measured or recorded in order to study it more objectively.

Piaget's theory provides a means of representing the informal way in which children conceive their world, which should make it possible for the educator to chart a pathway from their own conceptual frameworks and more intuitive methods of inquiry to the more scholarly ones the school seeks to help them attain. By bringing them along such a pathway, it should be possible to avoid much of the present frustration that both children and teachers experience and to give them a more balanced competence in intellectual methods. However, accomplishing this is sure to require a great deal more special competence on the part of teachers than current instructional methods do. In particular, teachers will have to become adept at making on-the-spot judgments as to which of several alternatives is of the greatest educational value. This requires ability to judge children's motives (whether intrinsic or extrinsic to the matter on which they are working), if the latter, whether there is a reasonable chance that intrinsic motivation can arise from the extrinsic ones at a given stage of intellectual development. It also requires that there should be immediately available, tested materials which children are likely to enjoy using and which are likely to provoke them into a desirable kind of activity.

Judging whether any ongoing interaction between children and their environment is educationally valuable or not is perhaps usually no more reliable a process than judging whether a given competence other terminal behavior, or goal is educationally valuable. We lack adequate means of doing either. It may be expected to be more valid because activities always need to be justified to children, their parents, and teachers as intrinsically valuable. Second grade should be a "good year" not just a good preparation for third grade. Perhaps there is merit, from the practical point of view of teacher training and teacher assessment, in emphasizing the judgment of on-going activities--recognizing that in some instances the ends-means continuum starts and stops with a particular value judgment made on the spot and, in other instances, that it may be traceable through a complex of causal inferences to some more permanently held goal.

J. A. Easley, Jr.
October 20, 1969

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USE OF COMPUTERS IN SCIENCE EDUCATION RESEARCH

Introduction.--Computers have come to play a more dominant role in both our ongoing instructional activities as well as within educational research. On the one hand, the computer's capability for resolving problems of accuracy, logistics, and complexity have added significantly to large group instruction. Perhaps, more importantly for science education research, computers allow for process control experimentation. The major point of this presentation will be to illuminate how process control experimentation in science education may provide more meaningful answers for your future research activities.

Unfortunately, the use of computers tends to be known by the nature of their application. When considering the term"Computer-Assisted Instruction" (CAI), one thinks of the following kinds of applications:

1. Drill and practice that provides a potential automation of the problem solving routines or homework to be mastered by a student.
2. Tutorial approaches that attempt to replace the teacher in as complete a manner as possible.
3. Problem-solving tasks that use the computer both as a problem-structuring device and as a calculational device for generating answers.
4. Simulation that attempts to replace many of the empirical activities such as found in a science laboratory with symbolic representations handled by the logical and stochastic capabilities of computers.
5. Evaluation via computer that leads to both sequential testing and more sophisticated forms of data analysis.

These alternative interpretations of CAI are listed primarily to indicate the wide range of computer aids to science education research. The problem, though, remains one of developing a theoretical framework so as to understand under what conditions and for what purposes a computer can be wisely utilized. For the purpose of this paper, I will intersperse questions to hopefully provoke later discussion and gain greater insight as to the nature of the conditions and potential payoffs from the use of computers.

Question 1.--How should we formulate the theoretical framework for the use of computers in science education research, given that the range of applications start from "here and now" instructional uses to potential, esoteric activities like simulation?

Question 2.--How might we separate out the goals of research from the goals of instructional development in order to gain greater insight as to the potential payoffs from the use of computers?

As a tentative answer, I have formulated three levels of research purposes and associated activities. While initially these three levels seem to span along the continuum from basic to applied research, it will become clearer that the nature of the three levels both interact and represent complexities among them that are highly important.

Level I.--Behavioral Processes Within Science Education Tasks. The main purpose of many researchers is the identification and explication of relationships among the basic behavioral processes within a student as he attempts to successfully complete a science education task. Borrowing liberally from experimental psychology as a source of theoretical concepts, the areas of perception, learning, memory, and rule-governed behavior have been looked at seriously via the use of computers. In regards to perception, the basic processes of discrimination, both among simple signals and symbolic representations, have been actively pursued by William Uttal at the University of Michigan. Utilizing computer control, the approximation steps or span of confusibility between two discriminatable stimuli have been systematically altered in order to better reveal the nature of discrimination processes. The major outcome has been an elaboration of the complexity of the similarity and difference sequencing rules for embedding within an educational task. This outcome is of special importance in terms of its implication for curriculum construction.

In turn, Gagne has proposed a hierarchial framework for considering the complexity of seven learning processes. Utilizing Gagne's backward iterative task analysis procedure, colleagues at Florida State University are using computers to test out the relationships and sequencing among the processes proposed by Gagne for a given science education curriculum. In turn, the role of memory has come to play a greater consideration within people's views of the basic nature of human problem-solving. Such work as exemplified by Johnson at the University of Minnesota in focusing on the conceptual associations found within physics exemplify this investigation. The role of the computer in this line of investigation has been one of both controlling the timing of input and retrieval events and attempting to span the zones of understanding that have been recognized by such people as Brown and Suppes.

And lastly, investigators such as Jenkins have been closely looking at rule-governed behavior and especially as to how these rules are acquired. These rule-governed behaviors may, in fact, characterize much of the conceptual understanding found in the physical sciences. Utilizing novel tasks, Jenkins has been exploring the nature by which adults infer rules to solve complex tasks via the use of a computer. Thus, all of these investigators can be characterized as attempting to better understand the behavioral processes within an instructional task. Giving secondary importance to the nature of the task or the precise experimental conditions, the role of the computer is primarily one of giving better control over the experimental conditions. This leads in turn to the following questions.

Question 3.--Precisely how does process-controlled experimentation via computers give one better insight into the behavior of students?

Question 4.--Should our experimental designs of the future involve more sequential stages by which we have a better interaction between the experimenters' evaluation of the data and the conditions posed in sequence for a student within a complex experiment?

Question 5.--How might on-line data analysis results influence the growing complexity of these potential experiments?

Level II.--Instructional Processes Within Science Education. Researchers who focus on instructional processes tend to posit a broader framework that involves at least the conceptual nature and structure of the learning materials, the current level of performance of the students as well as the nature of the instructional process itself.

Within the "systems model" for instruction, the first component usually concerns the learning goals and curriculum content structure. For science education it has been proposed that the basic relationship between the structure of the curriculum concepts and the behavioral processes to be gained by the student should have a closer relationship. Perhaps computers might facilitate these relationships by the simple means of simulating both the content and the student as a series of algorithmic steps within a student-curriculum simulator. While this is pure conjecture at this point, people are attempting to investigate this possibility, as noted by the work of the Stanford group in mathematics.

In turn, consideration of the entry performance level of the students is typically considered. Computers are being utilized for their more effective surveying and identification of strengths and weaknesses of given students. Third, the role of behavioral objectives has come to play almost a major theoretical influence within this second level of instructional processes. How the computer might relate to these behavioral objectives in an instructional form is still in its most exploratory stage.

The fourth component, that of instructional strategy is both the most ambiguous, and the one with greatest promise for future research. It can be contended that instructional strategies can be broken down into four types of psychology of instruction. One, there needs to be a psychology of directions for instruction, as might be illustrated by the use of flow charts, or sequentially structured steps as opposed to our typical verbal directions offered to the students. We have little understanding of the functions of directions and how these interact with students. Second, there is a need for a psychology of presentation that especially focuses on the role of media as it transcends just the best representation of concepts. The investigation of student aptitude by media interaction is one current example of research in this area. Third, there is a need for a psychology of instructor/student dialogues. While naturalistic observation schemes have been utilized in this area, the nature of these dialogues can become much more precise as one attempts to implement them on computer systems. And lastly, there is a need for greater understanding of the relationship between the psychology of errors, the process for correction, and the assignment of remediation.

People working in this second level would propose a different way of considering the behavioral processes of students in developing new psychologies that are distinctly different from that of experimental psychology found in Level I. As a last step, computers have played a significant role in the evaluation of a new curriculum. This has primarily been in more sophisticated ways of relating the outcomes to the particular cost. A few remarks in terms of cost effectiveness might be pertinent in one's long term view of a program of research. This "Systems Approach," thus can lead to the following kinds of questions.

Question 6.—How might computers be utilized for the analysis and generation of new science curriculum materials?

Question 7.—How might computers be used in the more appropriate assessment procedures for the entry or curren behaviors of students within a given instructional sequence?

Question 8.—How might computers be utilized for a better dialogue, especially in regards to their awareness of an involvement with the behavioral objectives of the curriculum?

Question 9.—How might computers be utilized within the formal investigation of instructional strategies, especially as emphasized between the degree of learner control of the process as opposed to the instructional systems control?

Question 10.—How might computers be utilized for a more timely form of evaluation?

Level III.—New Instructional Systems for Science Education. There are many investigators who, sounding almost atheoretical in their commitment, are attempting to develop new instructional systems. These investigators look upon the computer primarily as a problem-solving device to be used by the student for gaining greater sophistication and mastery of the goals of a given science curriculum. But more importantly, they are attempting to develop new science tasks that are more simpatico with the ultimate goals of science education. As examples, there are those who are attempting to automate the homework process and make the prescription of the amount of homework a function of both student's performance as well as the expectations from the instructional system. Secondly, many investigators are creating new science games, as well as problem solving tasks that depend on the computer for solution. In what sense does learning how to program a computer add to the behavioral process underpinning of a student as he ultimately approaches a career in science. And, last, but perhaps most importantly, there is a very active investigation of the replacement of many science laboratory activities with computer simulations. Perhaps the outcome of this is still premature, but the present results are highly promising. While many other new examples of instructional systems tasks using computers could be named and are currently being created at this time, the following questions seem to be reasonable results.

Question 11.--Can one identify the characteristics of the computer as a problem-solving device that could best match the assignment to some science task, be this laboratory or conceptual in nature?

Question 12.--How does the cost of technology relate to the ultimate cost of these new instructional systems?

I trust this brief outline and accompanying questions will prove sufficiently provocative that during my oral presentation you will feel free to identify the questions most relevant for your current interests and commitments.

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THE DESIGN OF RESEARCH IN SCIENCE EDUCATION ON THE BASIS OF LEARNING THEORY*

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Research Should Emerge From and Contribute To Learning Theory

In 1963, the Journal of Research in Science Teaching was launched. The first paper in this Journal was "A Preliminary Statement on Research in Science Education" (7). In that paper this writer argued that there is a need for basing science education research on learning theory. It was suggested that cybernetic theory may have some value in the design of learning, but that there appeared to be no adequate learning theory and virtually no evidence that science education research in the past had been based on learning theory. Also in 1963 David Ausubel published his book, The Psychology of Meaningful Verbal Learning (1). When my students and I first studied this book, we felt that Ausubel had assembled what could become a useful theoretical base for the design and interpretation of research in science education. The later books by Ausubel and his associates (2,3) have expanded considerably the theoretical formulation presented in 1963 and now provide what I believe to be a very adequate base for designing and interpreting research studies.

At this time, then, I submit we have an important theoretical base for the design of research in science education. You may wish to explore the theoretical suggestions of Bruner (4), Gagne (5), Piaget (6), Smith and Smith (12), Skinner (10), or other psychologists, but in the judgment of my graduate students, Ausubel presents at this time the most heuristic theory for proceeding in the design and analysis of research.

The critical distinction Ausubel elucidates is between rote reception learning and meaningful reception learning. In rote reception learning new knowledge learned is not associated to form some kind of conceptual base or is not associated with prior concepts; whereas in meaningful reception learning, new knowledge is associated to ideas or concepts in the learner's cognitive structure. The task for effective reception teaching is to plan instruction so that new material can be learned meaningfully, and it is to this end that Ausubel directs his attention.

In figure 1 a schema is shown to illustrate several important elements of Ausubel's theory. Meaningful learning occurs when there exists in the learner's cognitive structure some representational equivalent between language and mental content. The cognitive structure is represented in figure 2 by a network labeled "subsuming concept". Subsuming concepts allow related new information to be readily accepted into a learner's cognitive structure, with the subsequent loss of identity or dissociability of the acquired information "bits". Ausubel refers to this as obliterative subsumption, and this always occurs after new information is meaningfully acquired. Though obliteration of recall of specific knowledge bits occurs during subsumption, conceptual structure is enhanced, thus facilitating further acquisition of new knowledge. An important factor is that newly learned material is not immediately subsumed but as time proceeds, the new knowledge becomes progressively less dissociable from the generalized concept until it can no longer be recalled. Thus, subsuming concepts facilitate new learning and short-term retention, but eventual loss of discrete knowledge bits also occurs as cognitive structure is elaborated. Knowledge bits not associated with concepts may be rotely learned (open circles in figure 1)or may not be accepted into the cognitive field (repelled solid circles). However, rotely learned knowledge suffers relatively rapid irretrievability.

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Concepts can be related to each other or to some larger concept. For example, the concept of mass and force can be related to acceleration. As a learner acquires new knowledge, prior concepts can be gradually subsumed into larger, more inclusive concepts. This hierarchical subsumption process increases further the facility with which new knowledge can be acquired. Not only does eventual loss of retrievable knowledge bits result, subconcepts may become progressively less dissociable as distinct entities.

The ideas of subsumption are central to Ausubel's theory regarding how meaningful reception learning proceeds. However, one may ask why new learning occurs in areas where the learner has had little or no past experience and hence no available subsumers exist. To begin, adults rarely encounter learning tasks where some prior ideational framework cannot be applied during early learning phases. Subsequent differentiation of new concepts can result to facilitate new knowledge acquisition and subsumption processes proceed. For young learners, e.g., elementary school pupils, new learning may be by rote until enough information is acquired that subsuming concepts can be formed. Ausubel holds that for learning in areas where prior cognitive structure of the students may not contain available subsumers, advance organizers can facilitate learning. Organizers are introduced in advance of the material to be learned and are presented at a higher level of abstractness, generality and inclusiveness than the content to be learned. For example, children might be instructed that the primary center of growth in plants is at the ends of the stems. Subsequent instruction may lead them to observe the size of leaves, length of internodes and general contrast between the morphology of stems near the ends in contrast to lower regions. The statement regarding the primary center of stem growth thus serves as an advance organizer. In practice, effective instruction for meaningful reception learning would require presentation of advance organizers in sequences with appropriate instruction spaced between these. Thus our hierarchical series of organizers, in descending order of inclusiveness, would be planned into the instructional sequence. Figure 2 is a schema to show how advance organizers may serve to associate prior rotely learned information and/or to provide "anchorage" or a subsumption base for subsequent instruction.

Critical Variables for Study

On the basis of Ausubel's theory, it would appear evident that the design instruction should give careful attention to the sequence in which concepts are elaborated. Instructional design requires that progressive differentiation of major concepts occur in a systematic manner. The use of advance organizers in the instruction should facilitate learning. An important kind of research would involve what Scriven (11) has called formative evaluation. Substantial research efforts are needed to see whether or not varying sequences of concept presentation results in more rapid assimilation of the concepts, as measured by learning times such as the time spent in audio-tutorial study, or by the better acquisition of highly differentiated concepts. The latter would be evidenced in terms of the relatively greater power of transfer of learned concepts to new situations.

The variable of time is one that is too often ignored in the design of research dealing with science teaching. Frequently we look only at relative achievement and ignore completely the time required by students to reach a certain level of mastery. Since it is becoming increasingly apparent that most normal students are capable of learning the subject matter we have to present, the time variable is in many ways by far the most important. One of the promising aspects of audio-tutorial instruction is that we have a systematic way of monitoring learning time, for most of the important learning occurs in the audio-tutorial study center and it is easily possible to record this time as suggested by Postlethwait and others (9).

Since we are interested not only in knowledge acquisition but in the organization of this knowledge, the research evaluation instruments should appraise the ability of students to solve problems different from those presented in instruction as well as the acquisition of factual information. The quality of concept learning is probably best indexed by the success a student has in solving problems in an area to which the concepts are relevant. It has been suggested that the relative level of concept attainment can be indexed by the relative difficulty of problems an individual learner can solve in a given subject area (8). There is increasing evidence that the development of concepts or subsumers as Ausubel refers to functional concepts; facilitates the acquisition of new, relevant information. Therefore, the acquisition of subsumers is important not only for transfer of learning to new problem situations but also for facilitation of the acquisition of new knowledge. This is illustrated in figure 3. In this figure we see that students who have been classed as possessing high analytic ability, that is these students can do better than their classmates on tests of problem solving ability in botany, also show a marked increase in proficiency in acquiring new knowledge for a given interval of study time. This kind of data is highly supportive of Ausubel's theory that the presence of highly differentiated subsumers in cognitive structure not only permits transfer to new problem situations but also substantially enhances the rate of new knowledge acquisition. Much more research on these variable is needed.

It was suggested above that time variable is an important but often ignored variable in learning research. Another form in which this variable should be analyzed is with respect to the efficiency of alternative instructional sequences. The audio-tutorial modality provides an easy opportunity for trying two or more sequences for attainment of defined learning objectives. By monitoring student learning time when they are assigned to one or the other of the learning sequences, and also by appraising their relative attainment at the end of the learning time, one has a two way index of the efficiency of alternative sequences. Examination of these sequences may suggest where redundancy or the lack of organizers or the inadequate development of necessary subsumers may have curtailed learning in one of the sequences. To be sure, an element of trial and error is involved in this kind of exploratory research, but this is what is called for in good formative evaluation and this kind of research is very much needed in the study of education.

Since students come to us with widely varying backgrounds, it is evident that they will have available to them a differing array of subsumers in cognitive structure. The student who is particularly interested in chemistry may have highly differentiated subsumers in this area which will facilitate learning in certain areas of another science. Conversely, the student who lacks these subsumers or who has a highly differentiated cognitive structure in another area such as history or literature may find little facilitation for learning science but a substantial facilitation for learning in another field. Therefore, it is less relevant to look at the factual information students have in a subject area as they enter a course but rather to attempt an assessment of the potential relevant subsumers they have for the discipline. The best method for this assessment is to present the students with micro-learning tasks and monitor the time required for them to attain given levels of achievement on these micro-learning tasks. This is, according to Ausubel's theory, one of the best indices for the availability of relevant subsumers and consequently, the best predictor of potential success in the course to be studied. Information from this type of pre-instructional analysis can be useful in the improvement of instructional design as well as in the better assignment of students in multiple section courses.

Relevant Research

If one is willing to extrapolate substantially from research findings, the entire literature dealing with the use of various media in instruction, varying group size and pupil achievement, student and teacher variables related to pupil performance, and personality attributes and their relation to performance all indirectly suggest how science instruction can be effective. Our own survey of much of the science education literature showed very few studies based on Ausubel's learning theory and it was necessary to extrapolate many of the findings or to guess at the methodology employed in the study to interpret the findings. The general picture obtained through this survey suggests that audio-tutorial approaches, being individualized in nature and employing a variety of media, should be more effective than traditional lecture-laboratory approaches for science teaching. Moreover, the important and powerful feedback arrangement that one has in an audio-tutorial center for identifying weaknesses in the instructional sequence permits a screening of instructional practices and a convergence toward more efficient instructional sequences than could ever be obtained under traditional approaches.

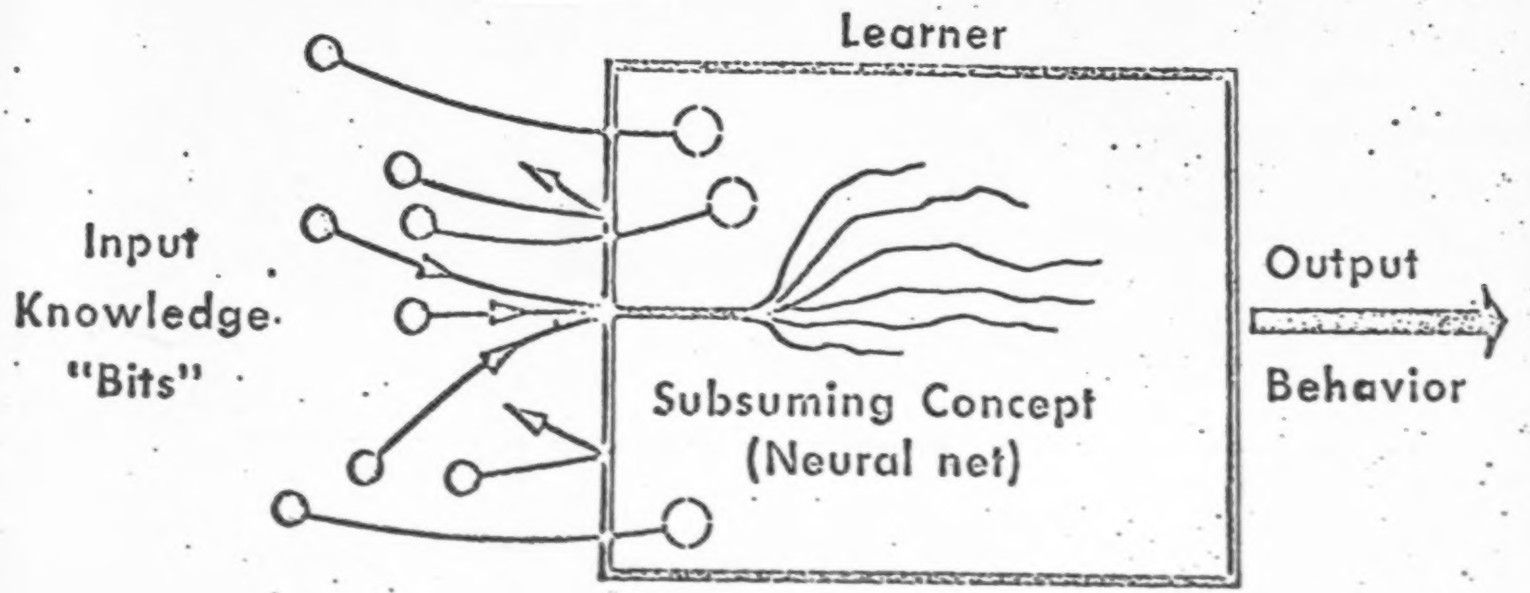
Learner
Input
Knowledge
"Bits"
Subsuming Concept
(Neural net)
Output
Behavior

Figure 1. Schema showing that knowledge bits which can be associated with an existing concept are accepted and "subsumed" to enlarge and strengthen this concept (meaningful learning.) Non subsumable knowledge bits are not accepted by the learner, or are learned independently (rote learning.)

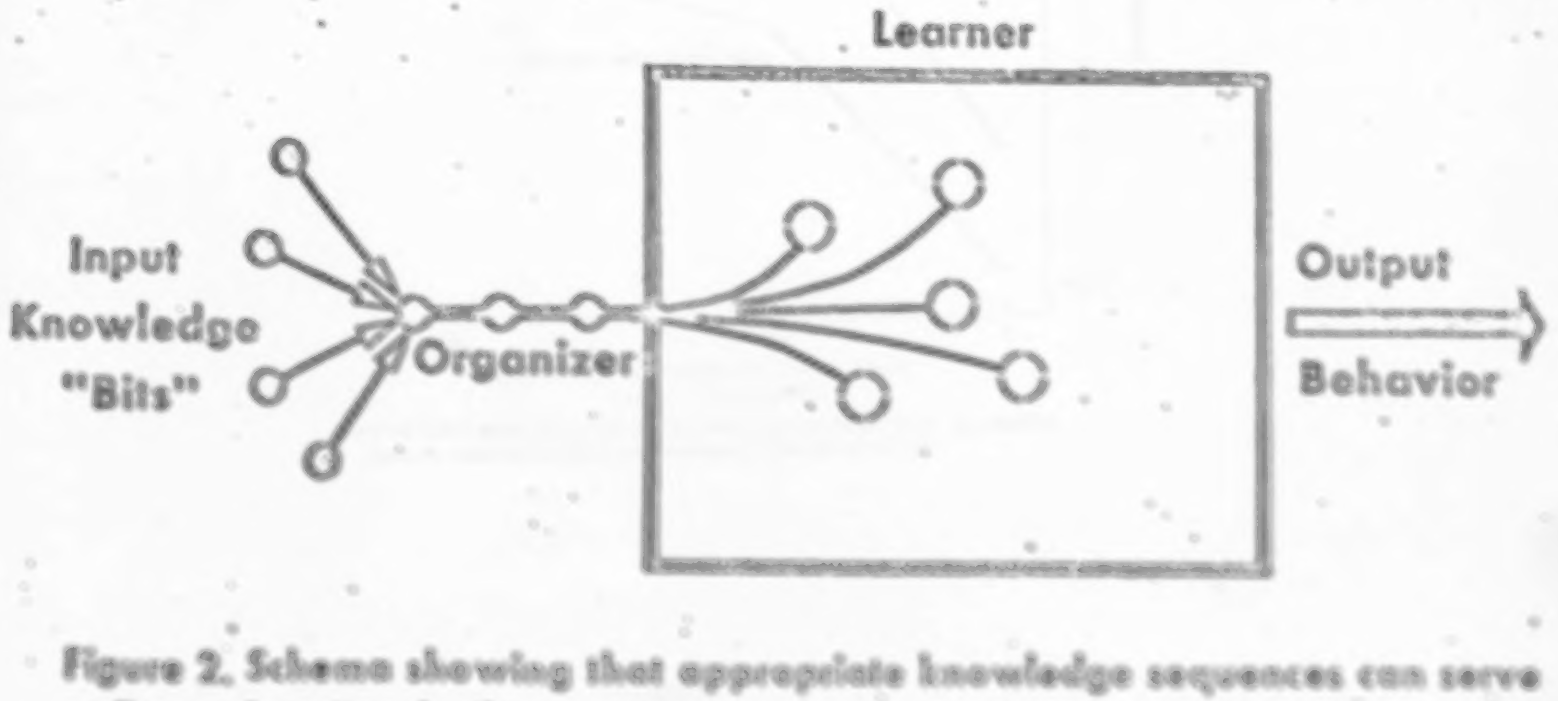
Learner
Input
Knowledge
"Bits"
Organizer
Output
Behavior

Figure 2. Schema showing that appropriate knowledge sequences can serve as "organizers" to facilitate subsequent meaningful learning.

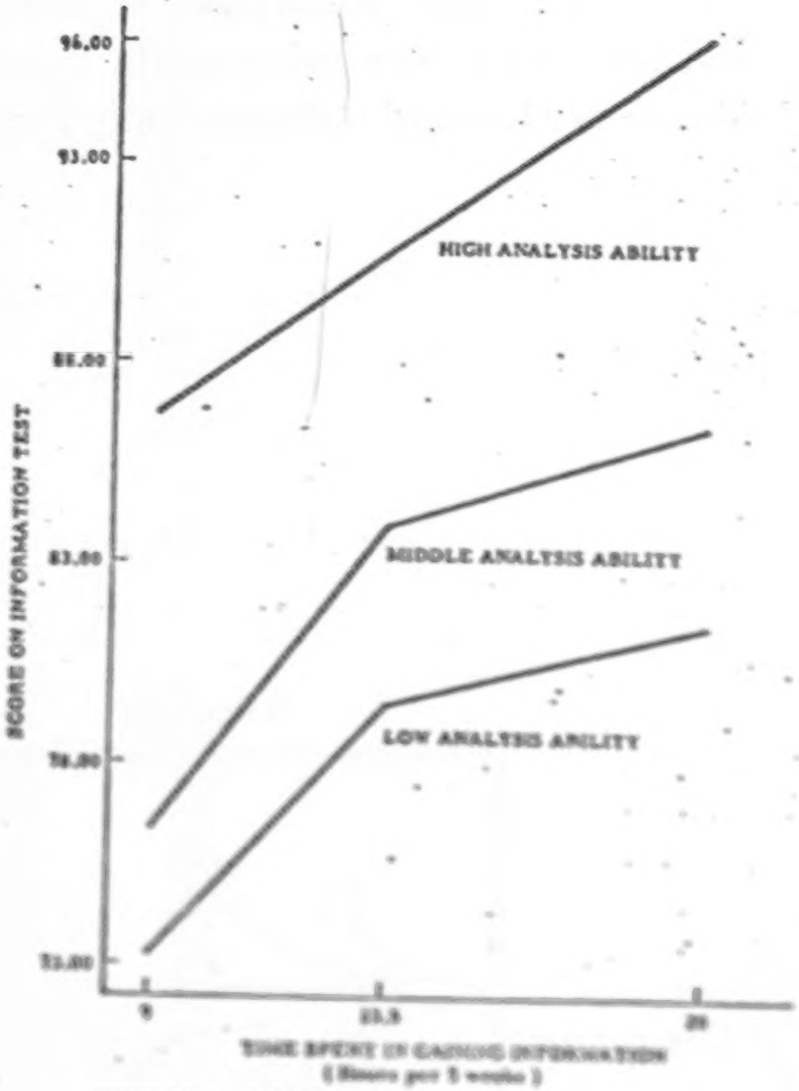

FIGURE 3. THE EFFECT OF ANALYTIC ABILITY AND TIME SPENT IN GAINING INFORMATION ON INFORMATION SCORE.

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Pre-session Information to Participants
NARST Research Training Session

STRATEGIES FOR CURRICULUM EVALUATION: Three Case Studies in Science

by

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The purpose of the sessions devoted to curriculum evaluation in science is to familiarize participants with some of the evaluation strategies and methods of analysis currently being used in science curriculum projects. The approach we shall follow is the case study approach. Three evaluation programs, one each at the elementary, secondary, and college level have been chosen to illustrate several of the recurring themes in the process of evaluation. The purpose of this paper is to define several elements of science curriculum evaluation and to offer some background information concerning each of the three projects.

I. What is Curriculum Evaluation?

There is a general lack of specificity regarding a definition of curriculum evaluation and its objectives. To provide a common ground for discussion, the following definitions are presented.

Curriculum is here defined as a set of materials or planned experiences designed to accomplish certain stated or implied objectives. In science, curriculum has traditionally consisted of syllabi, courses of study, and textbooks. Recently the science curriculum has been dominated by the alphabet programs sponsored by the federal government: PSSC, ESCP, SCIS, etc.

A distinction should be made between curriculum and instructional method. Curriculum is the content that academicians, society, and teachers decide children should learn. Methods of instructions are the means by which this is accomplished. Curriculum is the "what" that is to be learned. Instruction is the "how." Within these definitions, it should be noted, in fact expected, that there will be interaction between curriculum and instruction. Evaluation strategies should accomodate the possibility of this interaction.

Evaluation is the gathering of information for the purpose of making decisions. Curricular decisions generally are made by funding agencies, developers, and eventual users of a program. Evaluation differs from basic research in its orientation to a specific program rather than to variables common to many programs. The objective of educational research is to gain generalizable knowledge about the practice of education; evaluation seeks to provide a basis for making decisions among alternatives. Evaluation is concerned with questions of utility that has identifiable components of description and judgment.

Curriculum evaluation serves two important functions; first, it provides a means of obtaining information that can be used to improve a curriculum, and secondly, it provides a basis for decisions about curriculum adoption and effective use. The former is generally called formative evaluation, the latter is usually referred to as summative evaluation. The distinction between these two functions is in the manner in which the results are used. Are decisions made about a developing curriculum (formative) or is there need to reach decisions about a curriculum already completed (summative)?

Another component of evaluation seems to hover in the minds of curriculum developers and funding agencies. It is not formalized in the sense of formative and summative evaluation, but it is something I would call "supportive" evaluation. It grows out of the needs of men to receive reinforcement for

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things they have done. Individuals who have written a curriculum program need approval for their efforts. Similarly, funding agencies need evidence that the dollars they have spent on a curriculum development project have not been spent foolishly. The presence of this last kind of evaluation is often felt and at times tends to contaminate the other evaluation activities. Whether or not "supportive" evaluation evolves as a well defined goal will depend on the willingness of other curriculum evaluators and developers to recognize its existence.

II. The Case Studies

In each case study a decision was made by the curriculum developers to include evaluation in their program. The nature and purpose of the evaluation was not clearly specified, yet there was a feeling among the authors that some kind of evaluation should be attempted.

For the purposes of the training session, you are to suppose that you have been called in as an evaluation consultant to design and implement an evaluation program. A brief description of each curriculum is presented here for your information. None of the descriptions are very specific, but each typifies the usual starting point for curriculum evaluation. Most of the material was selected from statements of objectives written by the curriculum developers. Please read over each case study and formulate in your mind what you would suggest as an evaluation strategy. At the Research Training Program we will discuss some of the evaluation activities that actually were done and provide an opportunity for questions and criticism. In this way, a better understanding of evaluation strategies and methods of analysis should be obtained.

CASE A - THE CAMBRIDGE ELEMENTARY SCIENCE PROGRAM: An elementary science series developed by a commercial publisher.

Introduction

The project in which we are jointly participating is in many respects an educational adventure. While the development of an educational program is not new, the scope and organization of this project are unusual. To our knowledge, no science program other than those sponsored by agencies or foundations will have been given as rigorous and professional a trial as the Cambridge Science Education Program.

The Cambridge Science Education Program began as an idea some two years ago. The authorship was selected from the ranks of the leading educators, scientists, and science-writers across the country. In the interim from then until now, the authors and the representatives of the publisher have endeavored to structure the most current and sound science program possible.

The Program -- Point of View

Ultimately, the Cambridge Science Education Program will be a complete science curriculum for grades kindergarten through nine. The field test will involve student text materials for grades one through eight.

One of two approaches, at opposite ends of a continuum, is generally ascribed to an elementary science program. One is "content" and the other is "process". Each approach has its distinguishing characteristics, some of which are usually shared by the other. The Cambridge Program most accurately represents a blend of content and process, a wedding of the two points of view. As a meld, it gives due emphasis to essential content and to the processes of science which derive that and other content. There are few places in the program where either content or process is highlighted for its own sake. Rather, effort has been made to bring them together in a consonant and supportive manner.

The designers of the Cambridge Program hold these goals as paramount:

1. That the materials have scientific integrity; that is, that they will represent what the scientific community at large considers essential and non-trivial science;

2. That the materials be flexible and feasible; that is, that they can be effectively used, understood, and enjoyed by teachers and students of varying interests and talents;

Several steps have been taken to realize them. For example, five scientists are a part of the project team. They fill the central role of identifying for development those essentials of their individual disciplines which direct us toward the goal of scientific integrity. Others on the team represent the educational community and contribute to our realization of flexibility and feasibility. Three writers, of unparalleled stature, create the manuscript which is based on outlines from the scientists and on suggestions from the consultants and which, in its totality, comprises the basic program. An activities specialist prepares appropriate and integral investigations to strengthen the manuscript.

There are other characteristics of the program which are apparent in its contents. They are as follows:

1. The program is carefully articulated, vertically as well as horizontally, so that there is continuity and sequence of development through the grade levels and a cohesiveness at any one grade level.

2. Attention is given to the acquisition of learnings in depth.

3. The program gives emphasis to the spirit of science, to the nature of science and scientists, and to the relationship of science to other forces and developments in our society.

4. Through word, illustration, and activity, it is pointed out and reinforced that science is a human endeavor, that science is not always as clear a line as it often appears, that uncertainties permeate science, that science is, at times, free-wheeling and open, and at all times, dynamic.

5. Many opportunities are provided for children to investigate, to think, to ponder, and to question.

6. Finality and definiteness are not given the highest place. Indeed, there are times when ideas are presented as black-boxes where answers are not or cannot be provided.

7. This science program is for children to learn and teachers to teach. If the material fails them for any reason - inappropriateness, difficulty, readability, or whatever - every effort will be made to rectify the problem. Our major hope is success - for the learner and for the teacher.

CASE B - HARVARD PROJECT PHYSICS; a secondary school level physics course.

In 1965, this project decided to include research and evaluation as an integral part of its curriculum development. A considerable amount of material has been published concerning the evaluation of this program, however, the final results of the evaluation provide many examples of the variety of methods and techniques that can be utilized in curriculum evaluation.

Attached as an appendix to this document are copies of a newsletter describing the rationale and objectives of the course together with three reprints that explain the evaluation design that was chosen. For this curriculum project, we will concentrate more on methods of analysis and results than on designing an evaluation strategy.

CASE C - A college physical science course designed primarily for non-science majors.

The third case study which we shall examine has an additional component to those previously mentioned. It is a course that has already been completed and is in the hands of a comercial publisher. However, it was supported during development by a federal agency, and that agency has now agreed to support an evaluation of the program. Prior to attending the work sessions it would be useful to read the description of the course and consider the model of evaluation you would suggest. Statements of objectives and general rationale for the course are listed below.

GOALS

One of the major goals of this course is to improve the students' attitude toward science and to give them the feel of the scientist's approach. The project staff feels that neither of these goals is attained with a survey course which presents a wide range of factual material for the student to learn. The essence of science is not the learning of facts, but the asking of questions; not memorizing, but wondering; not being told, but trying to find out. Many of the students in a course such as this are prospective elementary-school teachers. Our goal is to convince them that they will teach science best not by knowing all the answers, but by encouraging the children to wonder about the world around them and perform their own experiments.

With this attitude, teachers will look forward to the science period in anticipation of cooperative exploration, not with anxiety about being unable to provide answers. The student under pressure to learn a large amount of subject matter hasn't time to wonder; to ask questions; to try to find out; to get into difficulty, as the practicing scientist does; nor to seek a better way of finding out. Yet without these time-consuming processes, a student cannot get the feel of science. To make time for the student to explore in this way, one must ruthlessly omit some areas of physical science that are commonly "covered" in a survey course and focus on some topic that lends itself to simple experiments with familiar materials, preferably one that shows the intimate interlock of physics with chemistry.

In this course the topic under study is the nature of solid matter - what it is like and how we find out about it. The text is called, significantly, AN APPROACH TO PHYSICAL SCIENCE. This is only one of the many possible approaches; other approaches will be used, we hope, at some future time in other courses - courses also generated for the purpose of giving students the feel of doing science. In a course with a focus, as opposed to a survey course, the topic in focus can be pursued in sufficient depth so that students gain confidence in results based on experiment, and thus see how we learn what we know.

Another member of the staff defines the course objectives this way.

> We feel that the major objectives should be the evaluation of changes in students' attitude towards science as a result of this course experience, and that a secondary objective should be the evaluation of improvements in the students' understanding of the processes of science and their ability to formulate questions and seek answers in the manner of a scientist.

The stated objectives of this course are listed below:

Substantive

1. To teach nonscience students how to go about studying natural phenoemena and how to formulate questions about physical situations.
2. To teach nonscience students how to propose models and hypotheses to aid in understanding the behavior of matter and energy.
3. To teach nonscience students how to design simple, controlled experiments to test their hypotheses.
4. To teach nonscience students how to analyze experimental results.
5. To stimulate an awareness of problems of current interest to scientists.
6. To provide for nonscience students a basis for recognizing the limitations of science.

Attitudinal:

1. To encourage the observation of natural phenomena, and to convey to nonscience students a sense of the beauty of the natural world.
2. To demonstrate the power of logical analysis, and to persuade nonscience students that with effort, every intelligent individual can learn to analyze events in a scientific manner.
3. To develop in prospective teachers an appreciation for the use of simple, scientific apparatus to illustrate an idea.
4. To generate in each nonscience student a confidence in his own ability to seek successfully answers to questions about the natural world.

Appendix

C-2. References Cited

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Appendix

D-1. Participants and Chairman of Problem Sessions

PROBLEM SESSIONS

A. Design of research training programs

Chairman: Fletcher Watson

C. Boener, K. Jerkins, P. Tweeten, R. Uffelman, H. Walbesser

B. Research involving A-T methods

Chairman: Samuel Postlethwait

R. Hansen, R. James, G. Myers, R. Wood, O. Dyrli

C. Writing and communicating research findings

Chairmen: Stanley Helgeson, Herbert Smith

G. Awkerman, S. Fowler, J. Hassard, D. Merkle, D. Schmidt, J. Trent

D. Dissemination of curriculum information

Chairman: J. David Lockard

R. Fitzgibbon, P. Koutnik, R. Menefee

E. Research on teaching style

Chairmen: John Montean, Stephen Winter

D. Arnold, W. Berryman, J. Bowles, H. Hein. W. LaShier, D. McCurdy, C. Nelson, S. Novick, J. Shaff, J. Schmuckler

F. Research on teacher characteristics

Chairmen: Willard Jacobson, Wayne Taylor

D. Butts, R. Olstad, E. Oshima, R. Yager

G. Research on inquiry teaching

Chairman: Robert Buell

R. Bingman, T. Cleaver, R. Doran, J. Gallagher

H. Special topics

Chairmen: Clarence Boeck, Milton Pella

H. Anderson, R. Bridgham, S. Schirner, A. Voelker

Appendix

E-1. Wolbasser Objectives and Assessment Tasks

OBJECTIVES

I - A : Construct a research investigation including the research hypotheses, operational definitions for the manipulated and responding variables, definition of the experimental unit, description of instrumentation, and procedures for execution.

II - A: Construct an operational definition for the manipulated and responding variables named in a research hypothesis, given a research hypothesis or a research report.

II - B: Construct an experimental design where the individual is the appropriate experimental unit.

II - C: Describe the appropriate experimental unit for an investigation, given a written description of the research.

III - A: Identify the experimental unit used by the researcher in a study, given a written report.

IV - A: Distinguish among nominative, denotative, connotative, and operational definitions, given a list of statements of definitions.

IV - B: Construct a research hypothesis for a written report of research, given the written report without the stated research hypothesis.

IV - C: Identify and name the responding variable and the manipulated variable in a research hypothesis, given a statement of the hypothesis.

V - A: Distinguish between examples and counterexamples of research hypotheses, given a list of statements.

V - B: Construct revisions in a research design to reduce the likelihood of a threat to an investigation for each threat identified by the learner.

V - C: Describe the data that could be provided in support of a responding variable measure, given a research hypothesis and/or a research design.

VI - A: Construct brief descriptions of research to illustrate each of the seven threats to the generalizability of conclusions.

VI - B: Construct revisions in a research design to reduce the likelihood of a threat (Campell and Stanley list) in an investigation for each threat identified by the learner.

VI - C: Describe the data that could be collected and presented to support each needed assumption in a research report, given a research report and a list of assumptions constructed by the learner.

VII - A: Identify and name threats to the generalizability of conclusions drawn in a research report.

VII - B: Construct brief descriptions of an investigation which illustrate each threat (rival explanation), given a list of rival explanations advanced by Campell and Stanley in their chapter in the Handbook for Research on Teaching.

VII - C: Identify and name the assumptions acknowledged by the author of a research report, given the research report.

VII - D: Identify and name the assumptions that need to be made to accept a researcher's conclusions, given a research report.

VIII - A: Identify threats to the validity of a research investigation's conclusion, given the description of an investigation and a list of rival explanations.

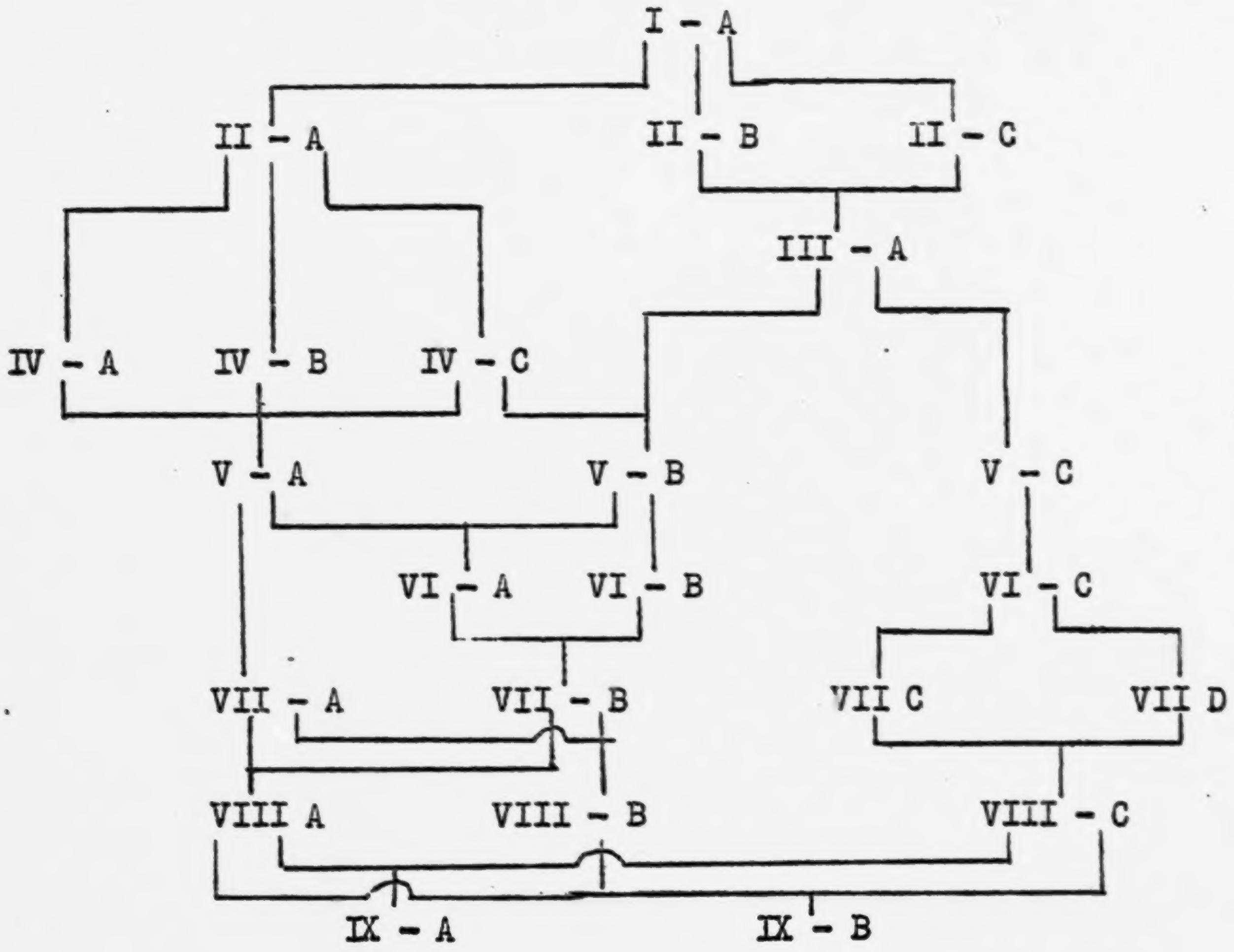
VIII - B: Describe whether a research report distinguishes among findings, conclusions, and recommendations.

VIII - C: Identify and name assumptions, given a simple argument.

IX - A: Distinguish among findings, conclusions, and recommendations, given a list of statements.

IX - B: Identify and name findings, conclusions, and recommendations, given a research report.

LEARNING HIERARCHY


I - A
II - A
II - B
II - C
III - A
IV - A
IV - B
IV - C
V - A
V - B
V - C
VI - A
VI - B
VI - C
VII - A
VII - B
VII C
VII D
VIII A
VIII - B
VIII - C
IX - A
IX - B

Assessment Tasks:

Definitions -

1. Findings: Findings are observations taken in the process of carrying out research or statistical manipulations applied to observations. For example, means, percentages, frequency distributions, correlations, results of statistical tests; decisions to reject or not to reject null hypotheses are findings.

2. Conclusions: Conclusions are value judgements related to the research hypotheses. After examining the research as a whole - - the design, the findings, the assumptions, and so on, the researcher concludes that either the research hypothesis for his study is supported or it is not supported. For every hypothesis, there is one and only one conclusion.

3. Recommendations: Recommendations are value judgements based on the conclusions of the research. They are usually related to (a) practice, (b) theory, or (c) future research.

I. Label each of the following statements as findings (F), conclusions (C), recommendations (R), or none of the three (N). Use the definitions provided to assist you in making your decision.

_____ A. The mean of the experimental group is 37.8.

_____ B. The hypothesis that the boys score higher than girls is supported by the data of this experiment.

_____ C. On the basis of this research, the school system should adopt the XYZ curriculum project materials.

_____ D. Boys scored higher than girls on the creativity test.

_____ E. The data yield a correlation coefficient significant at the 0.01 level.

_____ F. There was no difference in achievement between the students who had modern chemistry and those who had traditional chemistry.

II. Read research report one. Identify the author's (a) findings, (b) conclusions, and (c) recommendations.

A. Findings: ____

____

____

____

B. Conclusions: ____

____

____

____

C. Recommendations: ____

____

____

____

III. To what extent did the author of research report one distinguish between the findings and the conclusions?

____

____

____

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Appendix

E-2. Evaluation Letter and Forms

Founded 1928

Sponsoring The Journal of Research in Science Teaching

National Association for Research in Science Teaching

AFFILIATED WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

November 18, 1969

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NARST Research Training Program Participants

Dear Colleagues:

On behalf of the executive board of NARST, I should like to express appreciation for your participation in the first NARST Research Training Program. New programs, like new courses, have a number of rough spots that need to be ironed out for maximum educational value. We recognize in somewhat more calm retrospect that there were substantial areas for improvement in the program. I am sure you share with us the belief that at least some of our objectives for the training program were fulfilled.

Now that you can reflect upon your experience in the quiet of your study, I should very much appreciate a few minutes of your time to fill out the enclosed form. This form will be used as part of our summary report and will also be used by individuals concerned with the planning of future research training programs. Since I am anxious to complete the summary report, your cooperation in returning the form promptly would be appreciated.

Sincerely yours,

Joseph D. Novak
Director

NARST Research Training Program

JDN/km

Enclosure

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:
   1. identifying conceptual styles employed by pupils in learning
   2. observation of teacher-pupil interactions
   3. Classifying some learning structures of children and high school pupils
   4. identifying effects of teacher comments on child's learning activity
   5. identifying teacher insensitivity and misconceptions of pupil conceptualizatin
   6. gained some specific knowledge and ideas about how to employ Piagetian clinical interview approach for research purposes.
   7. relating Research paradigm (of Easley) to Thos Kuhn's Philosophy of Science)

2. The most valuable part of the program for me was:
   1. The experience of working with Jack Easley
   2. The presentation by Novak on organizers (using Ausubel)
   3. The sharp contrast in views of Atkin and Walbesser which served to focus some of my own ideas.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

I was in a work group where the leaders were too much like me in experience and knowledge. Furthermore they evidently had not been too well informed about their duties or had not prepared for the sessions. I got a few ideas but the session mainly reinforced what I knew before.

I should have switched - my own fault!

4. Participants I would recommend for leadership roles in future training programs are:

Welch
Walbesser
Atkin
Novak
Bridgham (from Stanford- not leader at this conference)
Easley
Maybe Winter or John Schaaf (not leaders at this conference)

Work Session Leader Boeck & Pella

Problem Session Leader(s) Easley

Thanks for the opportunity -

Submitted by: Harold M. Anderson

Harold M. Anderson

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained an interest in pursuing competence in the following research skills:

   Analysis of verbal communication as a means of determining cognitive structures in children and adolescents in small group and individual exchange.

2. The most valuable part of the program for me was: The work session dealing with unobtrusive measures of student-teacher behavior which can provide valuable information regarding how children think and the processes of teaching. The entire methodology seems to suggest a much more realistic orientation to research to prescribe content for curriculum and methodology design than the "expert opinion" methods that we have used in the past.

3. The least valuable part of the program was (provide reasons for your answer, if possible): The last two sessions of the problem group. I felt that these lacked value to me in that the problem sessions failed to focus on a definable problem in these sessions. My hope in the earlier sessions was that this would occur in later sessions and thereby add a great deal of meaning to what we were discussing. Instead, however, we continued even in the later sessions to be very circular in the discussions so that at the conclusion of the group of sessions, no conclusions were reached.

4. Participants I would recommend for leadership roles in future training programs are:

   Robert G. Bridgham
   William S. LaShier

Work Session Leader Jack Easley

Problem Session Leader(s) John Montean and Steve Winter

Submitted by: Daniel S. Arnold

Daniel S. Arnold

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

I received some additional insights into the development and use of affective evaluation instruments, i.e., Semantic Differential by Welch & Warberg.

2. The most valuable part of the program for me was:

the discussion of specific evaluation techniques and the enthusiastic hours of discussion with Wayne Welch, leader of the evaluation group and Herb Smith of the problem session.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

A time waste due to some lack in structure, i.e., the problem session. This is very minor compared to the overall gains. Perhaps more aggressive science supervisors from public schools could have added some practical slants to the program.

4. Participants I would recommend for leadership roles in future training programs are:

1. Wayne Welch - evaluation
2. A research design specialist (?)
3. Herb Smith - Communication
4. A public school science supervisor (?)

Work Session Leader Welch

Problem Session Leader(s) Smith

Submitted by: Gary L. Awkerman

Gary L. Awkerman

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

A SOUND BEGINNING TOWARD UNDERSTANDING AUSUBEL'S LEARNING THEORY AND ITS IMPLICATIONS FOR MY RESEARCH IN OUR SCHOOL SYSTEM.

2. **The most valuable part of the program for me was:**

THE WORK SESSIONS - Dr. NOVAK WAS, IN MY OPINION, OUTSTANDING - HE MADE ME THINK!

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

THE PROBLEM SESSIONS - WE "PLOWED OLD GROUND" MOST OF THE TIME - I FELT THAT "MAKING LISTS" AS WE DID WAS, IN THE MAIN, A WASTE OF TIME.

4. **Participants I would recommend for leadership roles in future training programs are:**

H. SEYMOUR FOWLER - PENN STATE
DAVID BUTTS - U OF TEXAS

Work Session Leader J. D. NOVAK

Problem Session Leader(s) John MONTEAN

STEPHEN WINTER

Submitted by:
William C. Berryman

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   a. To interpret research results from a standpoint of a given set of Assumptions.

   b. Practice in ~~identifying and/or~~ Stating research problems in Succinct Language.

2. The most valuable part of the program for me was:

   The interpretation of research results based on given Assumptions.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   The first Problem Session. We couldn't seem to get going. The background or experience of Participants was so vastly different and it was often difficult to relate it to pertinent Educational Problems

4. Participants I would recommend for leadership roles in future training programs are:

   Jim Gallagher, ERC
   Paul Koutnik, McREL

Work Session Leader JOE NOVAK

Problem Session Leader(s) D. Buolle

Submitted by: Richard M. Bingman
Richard M. Bingman

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills: I'm afraid I didn't stick with one work session. In fact I watched 3. I started with Walbesser but his arrogance drove me away. I did think he had come prepared however. It was his manner which I found hard to take.

2. The most valuable part of the program for me was: I thought the second day of my problem session was the best. We really worked out some interesting research problems for consideration. We did better the second day after Walbesser left and decided he need not run PhD oral exams in an obnoxious manner in that room.

3. The least valuable part of the program was (provide reasons for your answer, if possible): I thought the session involving Mike's presentation and the work session of his I attended. I think his point of view set research back a decade. You can't take philosophy as a replacement for research and expect otherwise. This was the wrong place to present this stuff.

4. Participants I would recommend for leadership roles in future training programs are: I'm not sure at the moment. I think we had a bit too loose an operation. I would rather consider the possibilities of people outside our group in many instances. These would, for example, include such in a variety of statistical areas or schools for various kinds of hypotheses to be tested. I would also suggest problem sessions be replaced by more work sessions and these be used in part to try to put the work sessions into two categories — preparation for doing certain kinds of work & application of these to kinds of problems brought up by the participants in that work group. We had too many widely separated activities going on and lack of continuity in some of them. I know I felt just that with regard to work sessions

Work Session Leader____________________

Problem Session Leader(s) Boeck

Submitted by: Clarence H Boeck

Clarence H. Boeck

Joe:
I should say in spite of all the above that this was still a good attempt and lots can be learned from its strengths and shortcomings. Thanks for the work involved!

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   I gained greater competence in analyzing proposals and reports of research; in identifying, stating and/or evaluating hypotheses, limitations, problem and hypothesis statements, assumptions, fallacies in design, fallacies in procedures and fallacies in conclusions.

2. The most valuable part of the program for me was:
   The most valuable part of the program was the opportunity to meet and talk to others interested in research; there was a great diversity in viewpoints.

3. The *least* valuable part of the program was (provide reasons for your answer, if possible):
   I resented the domination of parts of the sessions by persons doing "their own thing"--e. g., Watson's preoccupation with obtaining federal funding for research; Walbesser's narrow definition of research

4. Participants I would recommend for leadership roles in future training programs are:

   Henry Walbesser
   J. Myron Atkin

   I did not have enough contact with others to recommend them.

Work Session Leader Henry Walbesser

Problem Session Leader(s) Fletcher Watson (Walbesser sat in)

Submitted by: Charlotte M. Boener

Charlotte M. Boener

✓

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Undoubtedly I participated in the wrong sessions for my personal benefit. By no means should this be construed as to reflect on the leader(s) or topics—

   Perhaps, if additional programs are held, a more definitive statement of the structure for sessions would be valuable to prospective & selected participants—

2. The most valuable part of the program for me was:

   informal discussion, elaboration & "brainstorming" with other participants—

   Recommendation: (1) reduce the number of concurrent sessions & reorganize topics such that each participant has the opportunity to view the "whole picture".

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Re: item 1 above: duplication of "current knowledge?"

4. Participants I would recommend for leadership roles in future training programs are:

   In my opinion, your selection of leaders would be extremely difficult to duplicate; however, it might be helpful to utilize some "new blood" such as recognized leaders in related areas of research (psychology, general education, sociology, etc —

Work Session Leader Wayne Welch

Problem Session Leader(s) Herbert Smith

Submitted by: Joseph E. Bowles

Joseph E. Bowles

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

The interpretation of student and teach behavior in instructional settings: specifically the construction of "models" for beliefs from postural and linguistic cues.

The testing of hypothesized models of beliefs by variations in the tasks set for instruction.

2. **The most valuable part of the program for me was:**

The work sessions. The opportunity to practice skills on "real" materials and to discuss the contexts (research and practical) in which these skills might be useful was most helpful.

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

The problem sessions. Because the sessions lacked a clear focus and had no clear ties with any concrete problems they tended to generate "airy" argument and pontification.

4. **Participants I would recommend for leadership roles in future training programs are:**

Work sessions : Easley

Problem sessions: Boeck
Pella

Work Session Leader________________________

Problem Session Leader(s)________________________

____

Submitted by: Robert G. Bridgham

STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305

SCHOOL OF EDUCATION

December 30, 1969

Dear Joe:

I did some thinking about the research training sessions and would suggest three changes if we are to have a re-run. I thought the sessions were effective on occasions, but that too much time and energy were lost because of unfocussed, "what do they want" meandering.

1. Reduce the number of senior men involved. Most seemed to be at "loose ends" through the work sessions and to be "protecting" prepared value positions in the problem sessions.

2. Make the work sessions ninety per cent of the program and collapse the program to two full days. I'd suggest defining four or five problem- or skill-focused areas and designing a two-day program in each. The program for each area could be described in the prospectus for the overall program, and individuals would be asked to apply for the program in the area(s) they thought most pertinent to their own research interests. They could also then be asked to justify their need for training in that particular area. This would reduce the "floundering" that characterized the first day of the training sessions and might cut out some individuals who "came along for the ride."

3. Schedule the sessions immediately before or after an appropriate convention and in the same locale. AERA - NARST is already too long, but if the sessions were scheduled next to the AAAS or NSTA conventions some participants might manage to squeeze in an extra convention that they couldn't have attended otherwise.

Sincerely,

Bob

Application given to Kathie in Chicago. Do not have another form.

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

    1) Understanding of general techniques for programming CAI with respect to whole-course and part-course materials, including writing and evaluating global and detailed behavioral objectives.
    2) Contrast of Ausubel and Piaget models of development and cognitive growth, and the research techniques appropriate to within- and between-model testing.
    3) Extension of "inquiry skill" research to CAI and CMI models.

2. The most valuable part of the program for me was:

    1) Interaction on "inquiry techniques" with various others holding different definitions thereof.
    2) Off-session conversations about what research is going on in other places.
    3) New trends and research thrusts.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

    1) I felt the 15-min. preswntations by the 6 presenters of Work Sessions were too brief to gain much, and should have come AFTER the choice of sessions.
    2) My work session was less valuable to me than my Problem session, but the work session was the main thrust item.

4. Participants I would recommend for leadership roles in future training programs are:

    Dr. J. D. Gallagher, ERC, Cleveland
    Dr. Tom Cleaver, BSCS, U of Colo, Boulder

I WOULD LIKE TO RECOMMEND that at each of the 43 or so Sci Ed Centers some person be assigned to abstract for NARST annually and send to ERIC as a summary report entitled SCIENCE EDUCATION AT X UNIVERSITY 1969 all master's theses and doctoral dissertations (ca. 1000 words each) plus field studies, local studies, etc. AND

that these be printed on microfiche by ERIC as a continuing service; the dissertations ultimately may appear in DISSERTATION ABSTRACTS, but the theses never do---and sometimes these can be valuable.

Work Session Leader Hansen

Problem Session Leader(s) Buell

Submitted by:

Robert R. Buell

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

a. The ability to look at assumptions programs of research through both historic and futuristic models of research design.

b. The identification of specific research models with specific tasks rather than the fruitless search for one model to fit all tasks which can then be "molded" to fit the model.

2. The most valuable part of the program for me was:

The opportunity to share concerns, ideas, and the result in cognitive dissidence from the work sessions with Mike Adkin. This was most helpful and intellectually stimulating time.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

The problem session had a tendency to roam without clear focus.

4. Participants I would recommend for leadership roles in future training programs are:

Steve ~~Leonard~~ [illegible] would certainly be a possible suggestion.

Work Session Leader Adkin

Problem Session Leader(s) Taylor

Submitted by:

David P. Butts

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   None. I think this, however, a rather unrealistic goal in context with the way the program was organized. I should imagine it might have been better to identify some specific skills needed by participants and then to structure programs in such a way as to impart a gain in competence and to test the efficacy of that structure.

2. The most valuable part of the program for me was:

   Contact and the sharing of ideas relative to specific problems with research models, along with reviews and critiques of some research designs. I have also met and established lines of communication with people who are doing things that interest me.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   The problem sessions...simply because the function of the problem session was not carefully defined and it became--in some cases, though not mine-- a forum for the interests and personal prejudices of the problem leader. In my specific case, it became a forum for discussion and identification of researchable problems in Science Education.

4. Participants I would recommend for leadership roles in future training programs are:

   I have no specific recommendations to make based on this experience.

Work Session Leader Wayne Welch

Problem Session Leader(s) ~~Ro~~ Robert Buell

I consider the experience valuable and appreciate having been included.

Submitted by:

Thomas J. Cleaver

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Defining Research problems + variables

2. The most valuable part of the program for me was:

   realizing that much needs to done and that I may be able to contribute

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Limitation to one work and one problem session. Would have prefered spending one entire day on one topic and then another topic on another day, etc.

4. Participants I would recommend for leadership roles in future training programs are:

   Jim Gallagher
   Ron Raven

Work Session Leader Walbesser

Problem Session Leader(s) Buell

Submitted by: Rodney L. Doran
Rodney L. Doran

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained new competence in the following research skills:

1. ANALYSIS OF VIDEOTAPES OF TEACHING SITUATIONS WITH RESPECT TO TEACHER AND STUDENT STRATEGIES AND WITH RESPECT TO COGNITIVE STRUCTURING.
2. THE USE OF A/T METHODS AS:
   A. ASSIGNMENTS FOR GRADUATE STUDENTS TO DEVELOP, TEST AND EVALUATE
   B. PART OF SCIENCE EDUCATION COURSES THEMSELVES FOR EVALUATION
3. DELINEATION OF RESEARCH PROJECTS PARTICULARLY WELL-SUITED TO ANALYSIS THROUGH A/T AND VIDEOTAPING PROCEDURES.

ADDTL: WHILE NOT ASSIGNED TO WALBESSER'S SESSIONS, I OBTAINED HIS MATERIALS AND PLAN TO COMPLETE THEM AT A LATER DATE.

2. The most valuable part of the program for me was:

THE EXTENDED INFORMAL DISCUSSIONS — I HAD 4 *MOST* *VALUABLE* SESSIONS WITH WALBESSER + OFFELMAN; AND LUNCH WITH POSTLETHWAIT.

3. The *least* valuable part of the program was (provide reasons for your answer, if possible):

1. THE LACK OF CONTINUITY THROUGH HAVING A DIFFERENT DISCUSSION LEADER EACH DAY IN THE PROBLEM SESSION (OTHER GROUPS HAD THE SAME DIFFICULTIES SINCE SEVERAL LEADERS EITHER ARRIVED LATE OR LEFT EARLY).
2. THE VALUABLE TIME USED BY LEADERS IN ESTABLISHING WHERE PARTICIPANTS WISHED TO GO, INSTEAD OF COMING PREPARED TO LEAD THE GROUP IN DEVELOPING *SPECIFIC* SKILLS (PARTICIPANTS COULD THEN SELECT SESSIONS BASED UPON WHAT THE *LEADER* HOPED TO ACCOMPLISH).

4. Participants I would recommend for leadership roles in future training programs are:

WALBESSER
NOVAK
HANSEN

AMONG *PARTICIPANTS*: OFFELMAN, KOUTNIK

Work Session Leader J. CASEY

Problem Session Leader(s) 1) J. NOVAK (DAY 1)
2) S. POSTLETHWAIT (DAY 2)
3) J. MEYERS (DAY 3)

Submitted by: Odvard Egil Dyrli

Odvard Dyrli

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

An opportunity to hear others compare research methodology. Perhaps then a comparative "study" of existing research skills received as a result of exchange of ideas among members of peer group.

2. The most valuable part of the program for me was: the sharing of ideas regarding the missions of Sci. Ed. faculties. The idea that a Science Education research effort might be tied to a [illegible] psychology, Ausubel, was of interest. An opportunity to hear others discuss their efforts and to test one's own research focus in terms of peers' responses.

3. The least valuable part of the program was (provide reasons for your answer, if possible): Only one — The inability to relate Problems Sessions to the focus(ci) of the Conference — in other words, the other major session group.

4. Participants I would recommend for leadership roles in future training programs are:

Dr. Paul Bell — Teacher Behavior & Sci Ed Research

Dr. Michael Szabo — ~~[illegible]~~ A.T. Instruction & Sci Ed. Research.

(Both are members of my staff at Penna. State University).

Don't quote the following Joe. Only for your consideration. I'd like to lead a session (Problems perhaps) devoted to those Departments of Sci. Ed. who propose to develop their Depts. along eclectic lines so far as science ed. research is concerned e.g. w/o an area focus

Work Session Leader Joseph Novak

Problem Session Leader(s) Herbert Smith

Submitted by: H. Seymour Fowler

H. Seymour Fowler

Thanks again Joe for giving me an opportunity to participate.

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:
    - (a) Analysis of videotapes of small group interactions.
    - (b) Analysis of videotapes of individual interviews.
    - (c) Interpretation of data from interactions in small groups and in individual interviews.
    - (d) Formulating research questions.

2. The most valuable part of the program for me was:

    Work sessions on conceptual analysis of clinical interview and classroom situations.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

    Problem sessions on inquiry teaching largely due to the group leader's lack of any clear goal.

4. Participants I would recommend for leadership roles in future training programs are:

    In general, the leadership roles in this program were filled with highly competent people. However, some of the more incisive and insightful younger men such as Bob Bridgham and Tom Cleaver might provide better leadership than some of the less capable "old guard."

Work Session Leader Jack Easley

Problem Session Leader(s) Robert Buell

Submitted by: James Joseph Gallagher
James J. Gallagher

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Skill in evaluating the instruments used and data provided in curriculum evaluation. This sort of thing is quite basic and broad in its application to science educ. research. I intend to use some of these ideas in evaluating NSF Institute programs

2. The most valuable part of the program for me was:

Meeting with Wayne Welch and others interested in curriculum evaluation to discuss techniques and loopholes.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

Discussion of research priorities mainly because it was not debated. The problem area was allowed to disintegrate into a bull session (Teacher characteristics)

4. Participants I would recommend for leadership roles in future training programs are:

J. Myron Atkin
Addison Lee
* Wayne Welch
John Thompson of ESCP

Work Session Leader Wayne Welch

Problem Session Leader(s) Willard Jacobson
Wayne Taylor

Submitted by: Robert W. Hanson
Robert W. Hanson

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Techniques for curriculum evaluation which included the following:
   a. familiarization with a random sampling technique for large populations
   b. instruments for measuring attitudes and processes of science(semantic differential concept); also tests for physics achievements
   c. statistical techniques for handling semantic differential to identify clusters; statistical analysis of pre and post test designs

   All are extremely relevant to me since I will be carrying out a research project next year similar in design to those by Welch.

2. The most valuable part of the program for me was:

   Work sessions conducted by Wayne Welch and the gefneral address given by J. Myron Atkin.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Problem sessions: No new ideas were developed. My impression was that it was a re-hash of what have been editorialized in the JRST for the past five years. One possible mechanism for eliminating this problem was suggested by our problem session, namely correlate the work sessions with the problem sessions so that there are some continuity threads working through the training program.

   Except for this, however, I found the training program very valuable and well run.

4. Participants I would recommend for leadership roles in future training programs are:

   Gary Awkerman

Note: It would be rather interesting to bring these people together again to see if the program had any effect on them, to go in to more depth on the topics studied, and to develop other concepts relevant to research in science education.

Work Session Leader Wayne Welch

Problem Session Leader(s) Stanley Helgeson

Herbert Smith

Submitted by: John R. Hassard

John R. Hassard

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

A. Research design
B. Choice of evaluation instruments.
C. Communication of research findings.

2. The most valuable part of the program for me was:

A. Work Sessions
B. Contact with fellow participants.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

A. Problem Session
B. It would have been desirable to have had one group leader for both problem sessions!

4. Participants I would recommend for leadership roles in future training programs are:

Wayne Welch

Work Session Leader ~~John Montean, Stephen Winter~~ Wayne Welch.

Problem Session Leader(s) John Montean
Stephen Winter

Submitted by: Harold C. Hein
Harold C. Hein

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Instrumentation for evaluation of programs.

Designation of roles played by science supervisors in communicating research results - not truly a research skill.

2. The most valuable part of the program for me was:

Work Session - Program evaluation

Informal conferences - led to solutions for some specific problems, and to identify some new problems.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

Not enough carry-over between Work sessions and problem sessions.

(In many respects the session was not a training session so much as an exchange session.

4. Participants I would recommend for leadership roles in future training programs are:

Tom Cleaver
Alan Voelker
Wayne Welch

Probably fewer problem groups with more sharply defined focus for each would be better. As a first attempt, it was highly useful.

Work Session Leader Wayne Welch

Problem Session Leader(s) Herbert Smith
We combined our sessions { Stanley Helgeson

Submitted by: Stanley L. Helgeson
Stanley L. Helgeson

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   1. Analysis and comparison of various research styles.
   2. The delineation of significant problems that can be investigated.

2. The most valuable part of the program for me was:

   Problem sessions and work sessions

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Introduction to work sessions — The trainees did not have sufficient time to develop their ~~[illegible]~~ areas. However, it did help participants make a more intelligent choice of study groups

4. Participants I would recommend for leadership roles in future training programs are:

Work Session Leader Atkin

Problem Session Leader(s) Taylor

[illegible]

Submitted by:

Willard Jacobson

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

   Understanding of Ausubel's position with respect to learning psychology.

   How to apply Ausubel's ideas to educational research.

   Knowledge about how certain of the association's members feel about the fruitlessness of certain types of research (methods studies). Knowledge of certain potentially fruitful areas of research in auto tutoria methods.

2. **The most valuable part of the program for me was:**

   The opportunity to have personal contact with both the leaders and the participants in the conference.

   The opportunity to examine the ideas of both leaders and the participants and to present my own in the small groups. -------perhaps these observations are both related to my relative newness in th profession

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

   Perhaps the least valuable was the summary session----- although it may not have been possible for it to be very much different. I was left with with a concern as to whether or not we were going to get a rather complete transcript k of the work of each group.

4. **Participants I would recommend for leadership roles in future training programs are:**

   I really do not have any recommendations here. It seemed to me that all of those present were rather effective.

Work Session Leader Dr. Joe Novak

Problem Session Leader(s) Dr. Sam Postlewait

I sincerely appreciate the opportunity to participate! It was very beneficial to me and my work.

Submitted by: Bob James

Robert K. James

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   I learned how to design educational research based on the Ausubelian point of view. Also, I learned how to interpret reported educational research in terms of the Ausubelian point of view.

2. The most valuable part of the program for me was:

   The Work Session, the general sessions and the informal discussions between scheduled sessions.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   The problem session to which I was assigned never got away from discussions relative to Ph.D. programs, placement, cost and problems faced by the larger universities. I had hopes that we would get around to designing and planning for regional "research training by regional laboratories" and selected colleges, universities and public school systems.

4. Participants I would recommend for leadership roles in future training programs are:

   On the basis of my observations, I think that an excellent slate of leaders were selected for the November 12-14 session. Also, I was particularly impressed by the following participants:

   (1) Dr. Richard M. Bingman
   Mid-Continent Regional Educational Lab.

   (2) Dr. Alan M. Voelker
   R & D - Curriculum and Instruction
   University of Wisconsin

Work Session Leader Dr. Joseph D. Novak

Problem Session Leader(s) Dr. Fletcher Watson

Submitted by: Kenneth F. Jerkins

Kenneth F. Jerkins

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Comprehension of several alternative research styles. Comprehension of some problems attending sci. ed. research policy formulation (especially as it relates to alternatives to multivariate - behavioral styles.).

2. The most valuable part of the program for me was:

The research policy work session

3. The least valuable part of the program was (provide reasons for your answer, if possible):

Special topics problem session

reasons: a) very slow in task orientation

suggestion → in future, if participant interests do not all fit preassigned problem areas, allow the parties involved to (over)

4. Participants I would recommend for leadership roles in future training programs are:

① J. Myron Atkin
② Dave Butts
③ S. Winter

J. D. Novak (to continue as conf. director)

Work Session Leader Atkin

Problem Session Leader(s) C. Boeck - M. Rolla
J. D. Lockard

Submitted by: P. Koutnik
Paul G. Koutnik

either 1) choose a specific Session at the conference

or,

2) correspond with one another in advance of the conference to decide on a common interest which will then be the topic of a specific Problem session for them.

✓

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   I developed an awareness of the prevailing attitude among science educators that the research community must establish its credibility with the school personnel expected to implement change. I came away from the conference with the conviction that our future research should, in part, concentrate on learner needs and priority needs expressed by teachers in the classroom.

2. The most valuable part of the program for me was:

   The opportunity to discuss the problems that were relevant to a re-examination of the prevailing policy of science education research and specifically the problems of assessing teacher effectiveness in the classroom.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Our time was profitably spent in identifying the dimensions of problems related to specific research. There is a need, however, to bring such groups back together, after a lapse of 3 - 6 months to formulate and substantiate some concrete directions for finding answers to the questions that were initially formulated. The interval between meetings could be used by the participant to secure recommended microfiche studies, etc. and prepare individual position papers for informal dialogue at the second meeting.

4. Participants I would recommend for leadership roles in future training programs are:

Attended	Did Not Attend
David Butts	Julian Brandou
Stan Helgason	Mary Budd Rowe
	Paul Westmeyer

Work Session Leader Myron Atkin

Problem Session Leader(s) Steven Winter

John Montean

Submitted by: William S. LaShier

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

   The development of
   1. Techniques and strategies for curriculum evaluation and curriculum research.
   2. Increased awareness of variables affecting research in science education.

2. **The most valuable part of the program for me was:**

   The work sessions.

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

   Problem sessions

   Our group seemed to lack a sense of direction - although I realize that the determination of goals relative to research on teaching styles was one of our tasks. We had trouble focusing our discussion.

4. **Participants I would recommend for leadership roles in future training programs are:**

   I was extremely pleased with Wayne Welch's leadership.

Work Session Leader Dr. Wayne Welch

Problem Session Leader(s) Dr. John Montean

Dr. Stephen Winter

Submitted by:
Donald W. McCurdy

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Curriculum evaluation
  Uses of instruments including:
    1. Semantic differential
    2. Attitude Measures
    3. POSM
  strategy for curricular evaluation

2. The most valuable part of the program for me was:

Intimate contact with a public school official and a regional lab staff member that produced an awareness of their needs and research necessary to see how those needs can be met by appropriate services.

3. The **least** valuable part of the program was (provide reasons for your answer, if possible):

The introductory presentations (of the 6 principles) were not as stimulating and exciting as I had anticipated they would be. I believe these should have been more structured with adequate visual support.

4. Participants I would recommend for leadership roles in future training programs are:

Henry Walbesser
Duncan Hansen
Wayne Welch

Work Session Leader Wayne Welch

Problem Session Leader(s) Dave Lockard

Submitted by:
Robert W. Menefee

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

1. Identification of research questions, i.e., investigating for potential sources of variance;
2. Identification of research hypotheses, particularly through the use of changes in behavior;
3. Writing of relevant research proposals ~~that~~ (confidence at least !)

2. The most valuable part of the program for me was:

By far the most valuable parts of the program were the problem sessions. The exchange of dialogue with Dr, H. Walbesser and others challanged my thinking and warmed my interests in behaioral research.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

My inability to find an evening discussion group with whom I could continue dialogue. I suggest that some attempts at establishing volantary groups on selected topics be included in subsequent conferences.

4. Participants I would recommend for leadership roles in future training programs are:

Dr. Henry Walbesser
Dr. Richard Harbeck (I learned a great deal over lunch from this nemisis of U.S. O.E.)
Dr. Herbert Smith
and perhaps, other leaders from outside of Science Education who might be using techniques which we should apply.

Work Session Leader Dr. Herbert Smith and Dr. Stan Helgeson

Problem Session Leader(s) Dr. Henry Walbesser

Dale G. Merkle

Submitted by: Dr. Dale G. Merkle

Dale G. Merkle

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

   Use of computers in Science Education research. Strategies for Curriculum Evaluation.
   Designing research in Science Education of theoretical bases provided by Research in Learning Theory.

2. **The most valuable part of the program for me was:**

   Problem Session: Over a two-three day period in a small company of interested individuals, much ground can be covered and critical concerns examined with suggested recommended procedures for new directions.
   good location.
   well-structured time allotment.

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

   Lack of opportunity for analyses and confrontation with the main speakers - a vis-a-vis basis - due to time. We tend to get on tangents of individual concerns which are distracting and time consuming in a short conference schedule.

4. **Participants I would recommend for leadership roles in future training programs are:** Recommend that entire slate be re-united, on the basis of laving some experience, all could function more effectively. We are not doing as much as I'd like to see done with the applications of learning theory base to science education research - perhaps more experienced learning theory people needed here.

   Work Session Leader: Duncan Hansen

Work Session Leader Duncan Hansen

Problem Session Leader(s) Steve Winter

John J. Montean

Submitted by:

John J. Montean

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills: NONE

2. The most valuable part of the program for me was: to become aware of some of the research activities going on, to get what I could consider to be a managable set of references as background to setting up a research project, to realize that what I have been stumbling & fumbling to get started on (research in science courses) is an experience witnessed by most.

3. The least valuable part of the program was (provide reasons for your answer, if possible): I thought all aspects of the program was valuable. I wish I could have taken home some tools & skills to study meaningful criteria in teaching & learning & learn more criteria that should be subjected to test. Many of the criteria I thought would be valuable to study were suggested as meaningless in terms of learning theory & teaching procedures.

4. Participants I/would recommend for leadership roles in future training programs are:

Science Education professors who have done some meaningful research in learning theory, learning attitudes &/or teaching techniques, more specifically as it applies to media usage. I didn't rub shoulders in a meaningful way with enough people to realize their potentials in these areas. Of those there I suggest Uffelman, Yager, Bingman.

Work Session Leader Novak.

Problem Session Leader(s) Novak 1st day

Postlethwait 2nd day

None 3rd day

Submitted by: Gerald A Myers

Gerald A. Myers

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Curriculum Evaluation

   We are called upon to do course evaluations here, that is, various tracks of the same course. I got many useful ideas and procedures from attending Dr. Welch's sessions.

   I learned more about the merits and limitations of the Flanders Interaction Analysis technique.

2. The most valuable part of the program for me was:
   Curriculum Evaluation procedures.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   I could not find fault with anything. Some said they wished they had known before leaving home what some of the groups would be getting involved with so they could have brought certain materials along for use in the sessions. Maybe this would be helpful, though the complex problems of organizing a conference of this sort might preclude the possibility of doing more than was done.

4. Participants I would recommend for leadership roles in future training programs are:

   Dr. David P. Butts -- elementary science teaching
   Dr. Joseph S. Schmuckler -- don't know his specialty

   Dr. William Kessen, Yale University -- Philosophy of science teaching
   Dr. Gerald Holton, Harvard University --Philosophy of Sci. Teaching
   Dr. Bertram B. Masia, Univ. of Chicago =- The Affective Domain (?)
   Dr. William Mayer, Director of BSCS, Boulder, Colo. Curriculum Development
   Dr. Torrance, Univ. of Geor. -- Creativity and Teaching the Gifted.*
   (And someone to discuss problems of teaching science in the inner city--
   how to improve the self-concept in the underprivileged)

   Some of these probably don't belong to NARST, but might be helpful nevertheless.

   I thought that Dr. Atkin's presentation in the general session was excellent.

Work Session Leader Dr. Wayne Welch

Problem Session Leader(s) Dr. John Montean

Dr. Stephen Winter

Submitted by: Clarence H. Nelson
Clarence H. Nelson

*Dr. E. Paul Torrance is Chairman and Prof. of Educational Psychology, Univ. of Georgia, Athens, Ga. 30601.

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   1. Identification of a number of special instruments useful in sci. educ. research
   2. Behavioral objectives as applied to research design and analysis, esp. problem specification, variance determination, etc.

2. The most valuable part of the program for me was:

   Participation in the Work Sessions – It was here that the most "progress" was made.

3. The **least** valuable part of the program was (provide reasons for your answer, if possible):

   Except for the first problem session (where a lot of good ideas and experiences were discussed) the problem sessions I attended seemed to flounder because of lack of purpose or direction.

4. Participants I would recommend for leadership roles in future training programs are:

   David Butts
   Herb Smith
   Robt Yager

Work Session Leader H. Walberser

Problem Session Leader(s) W. Jacobson
W. Taylor

Submitted by: Roger G. Olstad
Roger G. Olstad

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Work Session - Research on the Basis of Learning Theory:
1. an awareness of the limitations of many current research in science education.
2. the role of learning theory in strengthening research

Problem Session - Research on Teacher Characteristics
1. Identification of problems relating to teacher characteristics and teaching
2. the need for a comprehensive listing of instruments used in science educ.-research.

2. The most valuable part of the program for me was:

The work session -- probably because I had not given learning theory too much thought
The opportunities to exchange ideas and opinions with colleagues on a multitude of research problems.

3. The **least** valuable part of the program was (provide reasons for your answer, if possible):

Introduction to Work Sessions. -- participants have already made a selection of work areas: Time may be used more effectively in starting work. Would it be possible for each work session leader to prepare a short introduction to be made available to the participants on which his selection would be made prior to the start of the Program?

4. Participants I would recommend for leadership roles in future training programs are: (of those with whom I participated)

David Butts
Silas Schirner

Work Session Leader Joseph Novak

Problem Session Leader(s) Wayne Taylor
Willard Jacobson

Submitted by: EA Oshima
Eugene A. Oshima

(over)

How can we encourage greater research effort in the state colleges where most of the teacher education takes place? It is discouraging to note that those institutions that have the greatest opportunity for research in teacher education do not provide the time or resources for research. (Note the few participants from state colleges)

Would it be possible to hold sessions for administrators -- presidents, deans of instruction, etc ?

For a first time program I thought it was pretty good and I am happy I was able to attend.

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:**

Situation analysis-Use of recorded classroom sequences in finding teaching difficulties.

2. **The most valuable part of the program for me was:**

Discussion with other people having problems similiar to those I am having. Opportunities to compare opinions relative to research procedures being employed.

3. **The least valuable part of the program was (provide reasons for your answer, if possible):**

General session in which there was no connection between the address and research. It received the most time and was of the least value. In addition it was a repeat of the speech previously given.

4. **Participants I would recommend for leadership roles in future training programs are:**

I will recommend some topics that we should tackle.

Sampling techniques.

How to treat available data rather than the most desirable data.(Data that can be secured from willing schools or populations rather than random samples.)

Development of instruments-Achievement-inventories-attitude-interest- Special interest should be directed to data treatment.

Research design that makes it possible to use a local school population and come out with meaning.

Work Session Leader Easley

Problem Session Leader(s) Pella Boeck

Submitted by: Milton O Pella

Milton O. Pella

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Identification and clear definition of specific and important research problems.

2. The most valuable part of the program for me was:

   The study conducted by Joe Novak on Thursday afternoon.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Each part of the program in which I participated was very much worthwhile.

4. Participants I would recommend for leadership roles in future training programs are:

   Gerald Meyers, University of South Dakota; Joseph D. Novak, Cornell University

Work Session Leader Novak

Problem Session Leader(s) Postlethwait

Submitted by: S. N. Postlethwait

Samuel Postlethwait

✓

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Conceptual analysis of classroom teaching based on analysis of video-tape recordings of "mini-class lessons. When applied to teacher education, this method of analysis, a type of formative evaluation, provides information which may be categorized as:

a) To gain insights on methods of working individually with potential teachers in teacher education programs

b) To acquire evidence of defects in a teacher education program and clues to its improvement

2. The most valuable part of the program for me was:

Frankly, I found all the general, work, and problem sessions valuable. The general session speakers presented a variety of ideas while the work and problem sessions provided an opportunity to examine through discussion two different specific areas of research.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

The summary session on Friday afternoon. This was due to the haste in which the reports were prepared and presented.

4. Participants I would recommend for leadership roles in future training programs are:

LaShier, William S.

Gallagher, James J.

Work Session Leader John A. Easley

Problem Session Leader(s) John Montean

Stephen Winter

Submitted by: John F. Schaff

John F. Schaff

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. **As a result of the NARST Research Training Program, I gained competence in the following research skills:** None. I did tape as many sessions as possible and may have a reference to some test or statistical treatment that I didn't have prior to the program.

2. **The most valuable part of the program for me was:** The work sessions with you (Novak) and our work with Ausubel's work. It has caused me to go back and take a second look at Piaget's work in relation to the things that were said in our sessions. The interchange in that session was good also.

3. **The least valuable part of the program was (provide reasons for your answer, if possible):** The 1st day's problem session. It became a power struggle between Walbesser and another participant as to who was the sharpest. It did not stick to the subject and the leader could not direct it in any other direction.

4. **Participants I would recommend for leadership roles in future training programs are:** Donald J. Schmidt and Jacob Blankenship

Note: I think there will be more latent benifits because of the tapes and articles that I acquired at the program. A possibility for future sessions would be to discuss a research proposal, design, andtopic at greater depth. Also a brain storming session of possible research topics would be benificial. Things that need to be researched at greater depth and things that need initial research done on them.

Thanks for including me. I hope I made some contribution to the group.

Work Session Leader Novak

Problem Session Leader(s) Clarence Boeck

Milton O. Pella

Submitted by: Silas W. Schirner

Silas W. Schirner

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

a. I became quite well informed about the use of ERIC publications and how they can be utilized by myself and my students in the study of related literature for research work.

b. I was introduced to a specific theory of learning and became well enough acquainted with the theory to apply it to research design and analysis. I had practice in conversing within the "framework" of the theory and also had practice in analysis of research in terms of this learning theory. I also was stimulated to start making preliminary research designs using this theory!

2. The most valuable part of the program for me was:

a. The intimate contact with persons who were sincerely "sold" on research ideas and the oppoortunity to work at length and in depth with one of these people.

b. The informal contact of others with similar interests and the ability to find out what is going on around the nation in Science Education research.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

a. The times I became "trapped" by some person who thought he knew everything and had all the answers to everyones problems. Certain of the "older" Science Educators simply love to hear themselves talk! Sad but true!

b. The summary sessions were weak. Each group must take more responsibility in making a meaningful final report.

4. Participants I would recommend for leadership roles in future training programs are:

Seek out people who have "something going", those who have a main thrust of research and study. Such as Henry Walbesser, Wayne Welch, Joe Novak, etc. Try to avoid those who try to be "jack of all trades" but in reality are masters of none. Others who are shaping research around specific psychologieal theories would be great. Example: Dr. Darrell Philips (Pigaetian psychology)

Work Session Leader Dr. Joseph Novak

Problem Session Leader(s) Herbert Smith

Submitted by: Donald Schmidt

Donald J. Schmid:

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Discerning researchable areas in Teacher Characteristics and Teaching Style, (an elusive topic to deal with.)

2. The most valuable part of the program for me was:

my sessions with Dr Duncan Hansen because of its immediate application to my current needs.

3. The least valuable part of the program was (provide reasons for your answer, if possible): not applicable to me

All topics that were discussed were needed. I wish I could have attended other sessions — I am looking forward to receiving the summary.

4. Participants I would recommend for leadership roles in future training programs are:

Dr Frank X Sutman

Dr Robt H. Buell

This program was excellent and timely for me — especially in terms of the needs that I expressed in my application to attend.

Work Session Leader Hansen

Problem Session Leader(s) MacLean + Winter

Submitted by: Joseph S. Schmuckler

Joseph S. Schmuckler

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Can't know that I gained any additional competence. Did help to sharpen up some problems and perhaps provided an even greater awareness to some of the needs of our time as far as research in science education is concerned.

2. The most valuable part of the program for me was:

Discussions in the problem sessions. Some of the work sessions also provide helpful insights - particularly Atkins.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

I didn't feel that Easley's presentation was very helpful.

4. Participants I would recommend for leadership roles in future training programs are:

Work Session: Roger Olstad.

~~Work Session Leader~~ (Gerry Ackerman (Good rep. for supervisor's point of view)

Problem Session Leader(s) ____________________

____

Submitted by: Herbert A Smith

Herbert A. Smith

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   Design, communication, and direction of research programs were the main areas of competence enhancement gained by participation in the research training program.

2. The most valuable part of the program for me was:

   The planned interchange of ideas with collegues. The program structure allowed for direction in this exchange as well as providing an opportunity for "chance events" to contribute to the constructs of the topic. There was an ample amount of direction without the oft encountered inhibiting effects of authoritative supervision.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   There was not a least valuable aspect in the program as such. The least exploited were a number of the participants. Only Dr. Atkin was provided an opportunity to address the group with any duration. I would like to have seen a number of the other session leaders given the same opportunity. Their remarks certainly would have contributed to the program.

4. Participants I would recommend for leadership roles in future training programs are:

   Dr. B. Ingman
   University of New Mexico
   Albuquerque, New Mexico

Work Session Leader J. Myron Atkin

Problem Session Leader(s) Fletcher Watson

Submitted by:

Paul W. Tweeten

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   1. Evaluation of strategies for assessing the proposed research training program in our institution.

   2. Strategies for analyzing research studies and judging their weaknesses in light of recent developments.

2. The most valuable part of the program for me was:

   Opportunity to participate in activity under supervision of experienced person.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Introductions to sessions - the overviews presented in these sessions could have been provided in writing prior to the session - they appeared to be "sales pitches" or "group psycho-therapy" sessions.

4. Participants I would recommend for leadership roles in future training programs are:

Work Session Leader Walbesser

Problem Session Leader(s) Watson

Submitted by: R.L. Uffelman

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:
   To me, the term competency is an inappropriate one for there were no objectives specified nor were there any measures of acquisition of skills. I do feel that I can now better (1) distinguish between problems and researchable problems and (2) identify concerns for programmatic research. Also, I acquired more awareness of the need to differentiate research responsibilities and to recognize that research training programs may not be compatible with the traditional graduate programs.

2. The most valuable part of the program for me was:

   The opportunity to interact with peers individually and in small groups.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   Being in sessions with persons with wide and varied interests, and abilities, made it difficult to concentrate on intended topics. (I derived some personal benefit from all sessions, but am not sure how much might be passed on to others in a direct manner.)

4. Participants I would recommend for leadership roles in future training programs are:

   People who have a plan for running their sessions - free wheeling is a good technique for some groups, but not when you expect an opportunity to acquire competencies.

   I would be happy to conduct a session on learning research in the elementary school, emphasis on the design of local programs.

Work Session Leader J. Myron Atkin

Problem Session Leader(s) Fletcher Watson

Submitted by: Alan M. Voelker

Alan M. Voelker

SUMMARY REPORT

NARST Research Training Program

November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

Careful analysis of research papers.

2. The most valuable part of the program for me was:

Exploring new ideas with colleagues.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

None really

4. Participants I would recommend for leadership roles in future training programs are:

Richard Weller - Harvard

Maurice Belanger - U. Montreal

Work Session Leader Walbesser

Problem Session Leader(s) Watson

Submitted by: F.G. Watson

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

clarified my understanding of the operational meaning of "styles of teaching" and got a conceptual framework for potential research in the area.

2. The most valuable part of the program for me was:

Discussion in the Work Session devoted to Policies in Science Education

3. The least valuable part of the program was (provide reasons for your answer, if possible):

Summary Session. — too hurried, diffuse, diverse

4. Participants I would recommend for leadership roles in future training programs are:

Butts,

Work Session Leader Atkin

Problem Session Leader(s) Morten

Winter

Submitted by:

Stephen Winter

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

- Identification of researchable areas in Science Education
- A technique for collecting children's performances via video tape
- Evaluation techniques associated with audio-tutorial instruction
- Research designs applicable to the area of cognitive development

2. The most valuable part of the program for me was:

- The chance to discuss research problems with other science educators. I gleaned many valuable ideas and suggestions from the participants.
- A chance to become acquainted with some of the "top" science educators in the country.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

The problem session - due probably to the fact that we lacked a permanent leader due to conflicts in assignments. This session never seemed to get off the ground relative to the problem of relating A-T to research strategies.

4. Participants I would recommend for leadership roles in future training programs are:

Jack Easley - Univ. of Illinois - I felt I left his session with a wealth of new ideas.

Roger Olstad - Univ. of Washington

Alan Voelker - Univ. of Wis.

Work Session Leader Jack Easley

Problem Session Leader(s) S. Postlethwait
J. Novak
R T Myers

Submitted by: Roger L. Wood

SUMMARY REPORT
NARST Research Training Program
November 12-14, 1969

1. As a result of the NARST Research Training Program, I gained competence in the following research skills:

   New measurements in determining teacher's characteristics

   Possible uses of CAI in research in learnind outcomes

   New models for science education research

2. The most valuable part of the program for me was:

   Group presentations and the exchange of specific ideas and tools which was facilitated in the small group seminars.

3. The least valuable part of the program was (provide reasons for your answer, if possible):

   The attempt at presentation in the work sessions. The questions and the answers from the group leader (CAI) didn't always mesh.

4. Participants I would recommend for leadership roles in future training programs are:

   Wayne Welch
   David Butts
   Addison Lee

   Robert Lepper
   Ernest Burkman
   Paul Hurd

   Work Session Leader: Duncan Hansen

Work Session Leader Duncan Hansen

Problem Session Leader(s) Wayne Taylor

Willard Jacobson

Submitted by:

Robert E. Yager

Appendix

F. Copy of Proposal to U.S.O.E.

3

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION
BUREAU OF RESEARCH
WASHINGTON, D. C. 20202

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APPLICATION FOR RESEARCH SUPPORT

Descriptive Data

TYPE OF PROPOSAL

NEW ④ X
REVISION OF BUREAU NO. ⑤
SUPPL TO CONTRACT NO. ⑥
CONT OF CONTRACT NO. ⑦

TITLE OF PROPOSAL

⑧ A Research Training Project in Science Education
⑨
⑩
⑪

PROPOSED START DATE ⑮ 5-1-68
PROPOSED END DATE ⑯ 12-31-68

PROJECT DIRECTOR

NAME ⑲ Joseph D. Novak
TITLE OF POSITION Professor, Cornell University
HIGHEST DEGREE ㉑ Ph.D
BIRTH DATE ㉒ 12-2-30
TITLE OF ADDRESS ㉓
SOCIAL SEC NO. ㉔

APPLICANT INSTITUTION

NAME ㉗ National Assoc. for Research in Science Teaching
SUBDIVISIONS MAJOR ㉘
MINOR ㉙
ADDRESS ㉚ E-30 McDonel Hall, Michigan State Univ.
CITY ㉛ East Lansing
STATE ㉜ Mich.
TELEPHONE ㉝ 518-355-1725
ZIP CODE ㉞ 48823
COUNTY ㉟
CONGRESS DISTRICT ㊱

OE USE ONLY
㉕

WHERE RESEARCH TO BE CONDUCTED (IF DIFFERENT FROM ABOVE)

INSTITUTION ㊵ Cornell University
ADDRESS ㊶
CITY ㊷ Ithaca, New York
STATE ㊸ N.Y.
TELEPHONE ㊹ 607-275-5410
ZIP CODE ㊺ 14850
COUNTY ㊻ Tompkins
CONGRESS DISTRICT ㊼

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SIGNATURE OF PROJECT DIRECTOR
DATE

OFFICIAL SIGNING FOR INSTITUTION
SIGNATURE
DATE

NAME ⑫ Joseph D. Novak
TITLE ⑬ President, NARST

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OFFICE OF EDUCATION
BUREAU OF RESEARCH
WASHINGTON, D. C. 20202

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Descriptive Data

OTHER KEY PERSONS

	NAME	BIRTH DATE	SOCIAL SECURITY NO.
(48)			
(48)			
(48)			
(48)			

TYPE OF ORGANIZATION (CHECK APPROPRIATE ONE)

OE USE ONLY
(49)

INDIVIDUAL ☐

PRIVATE INSTITUTION PROFIT ☐ NON-PROFIT ☒

PUBLIC INSTITUTION FEDERAL ☐ LOCAL ☐

STATE ☐ OTHER ☐

NAME OF US OE OFFICIAL PREVIOUSLY CONTACTED ABOUT THIS APPLICATION, IF ANY:

Richard Harbeck

PROJECT DIRECTOR'S TIME COMMITMENT IF PROJECT IS FUNDED	PERCENT OF TIME	ENDING DATE	FUNDING AGENCY
TEACHING DUTIES (IF NONE, LEAVE BLANK)	50	▨	▨
ADMINISTRATIVE DUTIES	15	▨	▨
RESEARCH IN PROGRESS, TITLE OF PROJECT			
1. Elementary Science Project	20	6-30-69	USOE
2. Concept Learning in Science	10		
3.			
4.			
CONSULTANT SERVICES			
TIME PLANNED THIS PROJECT	5	▨	▨
OTHER			
TOTAL	100		

IF YOUR PROPOSAL IS A TRAINING PROJECT, COMPLETE THIS SECTION

A. TYPE OF PROPOSAL

☐ UNDERGRADUATE
☐ GRADUATE
☐ POST DOCTORAL
☐ INSTITUTE
☐ SPECIAL TRAINING PROJECT
☐ PROGRAM DEVELOPMENT

B. INSTITUTIONAL ALLOWANCE
1. BASED ON RATE PER TRAINEE

NUMBER OF TRAINEES	RATE	AMOUNT

2. TOTAL INSTITUTIONAL ALLOWANCE

C. TRAINEE SUPPORT
1. STIPENDS

NUMBER OF TRAINEES	STRIPEND RATE	AMOUNT
50		
	SUBTOTAL	

2. DEPENDENCY ALLOWANCE

NUMBER OF DEPENDENTS	RATE	AMOUNT
	SUBTOTAL	

3. TRAVEL RELOCATION COSTS 10,000
4. TOTAL TRAINEE COSTS 10,000

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PROJECT COST ESTIMATES

TOTAL PROJECT COSTS

Federal

PERSONNEL SALARIES	(51)	$ 6,240
EMPLOYEE BENEFITS	(52)	$
TRAVEL	(53)	$ 4,500
SUPPLIES AND MATERIAL	(54)	$ 100
COMMUNICATIONS	(55)	$ 500
SERVICES		
DUPLI AND REPRO	(56)	$
STATISTICAL	(57)	$
TESTING	(58)	$
OTHER	(59)	$
FINAL REPORT	(60)	$ 1,000
EQUIPMENT	(61)	$
TRAINEE COST (PG2 C4)	(62)	$ 10,000
INSTUTITIONAL ALLOWANCE (PG2 B2)	(63)	$
OTHER DIRECT	(64)	$
SUBTOTAL DIRECT COST	(65)	$ 12,340
INDIRECT COSTS	(66)	$ 1,787.20
TOTAL PROJECT COSTS	(67)	$ 24,127.20

CHECK BRACKETS WHICH BEST DESCRIBE YOUR PROPOSAL

☐ ELEMENTARY EDUCATION
☐ SECONDARY EDUCATION
☒ HIGHER EDUCATION
☐ ADULT OR CONTINUING EDUCATION
☐ HANDICAPPED CHILDREN AND YOUTH
☐ VOCATIONAL EDUCATION
☐ EDUCATIONAL RESEARCH AND DEV. CENTER
☐ REGIONAL EDUCATION LABORATORY
☐ LIBRARY OR INFORMATION SCIENCE RESEARCH
☐ EDUCATION AND RESEARCH INFORMATION GATHERING AND DISSEMINATING
☒ TRAINING PROGRAM RESEARCH PERSONNEL
☐ OTHER ________________

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BUREAU OF RESEARCH
WASHINGTON, D. C. 20202

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ABSTRACT OF PROPOSED RESEARCH ACTIVITY

TITLE OF PROPOSAL: A Research Training Project in Science Education

PROJECT DIRECTORS NAME: Joseph D. Novak

INSTITUTION NAME: National Assn. for Research in Sci. Teaching

ABSTRACT (THIS IS FOR INTER-GOVERNMENTAL DISTRIBUTION, OMIT CONFIDENTIAL INFO. - 2000 CHARACTERS AND SPACES MAXIMUM)

The research training project will be concentrated in three training sessions involving fifty trainees and resource personnel. The training sessions will have the specific objectives of training participants, (1) to distinguish between problems requiring traditional research design and newer evaluative designs, (2) to learn how to apply learning theory in the design of research, (3) to learn techniques and skills needed for science education research, and (4) to learn what kinds of research shows most promise for improving education. Evaluation of the participant's accomplishments will be an integral part of each training session, with leadership personnel providing examples and requiring evaluative comment on examples as well as trainee originated examples. The most productive training practices evidenced may be used as a basis for "presession" research training projects prior to future annual meetings of NARST and other groups.

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A RESEARCH TRAINING PROJECT IN SCIENCE EDUCATION

Abstract

The National Association for Research in Science Teaching, herein proposes that a research training project for researchers in science education be conducted during 1968. The first phase of the project will be a session where resource persons will discuss preliminary versions of training plans and finalize arrangements for training sessions to be held in November, 1968. Fifty participants will be selected in September and October from among applicants indicating an active role and interest in the improvement of science education research.

The research training project will be concentrated in three training sessions involving fifty trainees and resource personnel. The training sessions will have the specific objectives of training participants, (1) to distinguish between problems requiring traditional research design and newer evaluative designs, (2) to learn how to apply learning theory in the design of research, (3) to learn techniques and skills needed for science education research, and (4) to learn what kinds of research shows most promise for improving education. Evaluation of the participant's accomplishments will be an integral part of each training session, with leadership personnel providing examples and requiring evaluative comment on examples as well as trainee originated examples. The most productive training practices evidenced may be used as a basis for "presession" research training projects prior to future annual meetings of NARST and other groups.

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A Research Training Project in Science Education

Sponsored by the National Association for Research in Science Teaching
Supported by
The U.S. Office of Education

PURPOSE

The national Association for Research in Science Teaching was founded in 1928 by a group of active workers in Science Education who recognized the need for exchange of ideas on research that could lead to the improvement of science teaching. The members of the Association, as well as other education research workers, have contributed a substantial body of literature reporting on research studies of a variety of kinds directed toward obtaining evidence which could be used to modify instructional practice, teaching materials, or science curriculum organization. Summaries of this research work have appeared as "Digests" prepared by the late Professor F.D. Curtis and more recent summaries have been published by the U.S. Office of Education. Though this research has contributed to our understanding of science teaching methodology and its affect on learning, there is widespread feeling that much of the work is fragmentary and lacks sufficient theoretical base to warrant broad generalization from the research settings to science classrooms across the Nation. Since the membership of NARST is committed to the premise that instruction in science can be improved through the application of research evidence, it is appropriate for this organization to sponsor a research training project.

Many senior professors responsible for training science education personnel are not familiar with new research techniques. A primary objective of this project is to advance the research skills of these people engaged in training future research works.

We have been through a decade of active educational curriculum innovation, most of which has been based not on the findings of research

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that has dealt with science education but rather on the intuitive feelings of experienced teachers and accomplished scientists. Though these efforts in curriculum development have done much to update the content of secondary and elementary science programs, the statistics on enrollments in subjects such as high school physics and surveys of public understanding of the scientific enterprise suggest that the new efforts still leave substantial room for improvement. The stage appears to be set for a new series of curriculum innovation efforts continuing the utilization of talents from experienced teachers and capable scientists, but adding whatever research findings are relevant to the design and execution of future science programs. This appears to be an appropriate time to draw upon our fund of research evidence on learning in science, and to identify critical areas, and to acquire research competencies necessary for intensive study by teams of investigators to improve science instruction.

Another objective of the proposed project is to provide examples of ways in which newer instructional technology can be used to improve research and teaching. Almost all of the new science curriculum programs have been dependent upon textbooks and laboratory guides used by teachers in much the same way as materials developed in earlier years and incorporating to only a very limited extent the potential of currently available instructional technology. The role of the new teaching technology for improvement of science instruction is another area where further research is needed, and participants will learn to identify research problems dealing with evaluation of instructional technology.

GENERAL OBJECTIVE: To train science education researchers in newer techniques and research methodologies.

SPECIFIC OBJECTIVES

1. Participants will be able to distinguish between problems requiring traditional research design and newer evaluative designs.
    a. Given ten research problems, participants can specify an appropriate research design for at least nine.
    b. Participants will learn ways to restructure research questions to permit use of better research designs.
2. Participants will learn how to apply learning theory to the design of research.

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   a. Participants will be able to state measurable parameters implied by a given learning theory for a specific research problem.

   b. Participants can indicate how problems do or do not bear on a given learning theory with success on at least four out of five examples.

   c. Participants will be able to state at least three research problems that relate to a given learning theory.

3. Participants will learn techniques and skills needed for science education research.

   a. Participants will learn how to write at least ten behavioral objectives that can be measured in research.

   b. Participants will learn sources of aid in statistical analysis and experimental design.

   c. Participants will learn how to make decisions on data necessary for answering specific research questions, with at least ninety per cent success.

   d. Participants will learn to specify how new technology can be used in research situations, and they will be able to provide examples for at least three out of four problems given.

4. Participants will learn what kinds of research shows most promise for improving education.

   a. Participants will learn the limited value of surveys and status studies and be able to specify these limitations for at least four out of five examples.

   b. Participants will learn the limitations of "methods comparison" studies and be able to state the extent of potential generalizability for at least four out of five examples.

   c. Participants will learn how basic questions dealing with cognitive development can associate teaching success with learning theory, specifying the relationship in at least four out of five examples.

ADDITIONAL OUTCOMES

1. New talent will be identified for leading future research training projects.

2. The most successful elements of this project will serve as one model for planning a research training program to be held prior to the NARST annual meetings in February, 1969.

3. Participants will seek additional professional and financial aid to improve the quality of their research work.

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PROJECT PROCEDURES

Step 1. It is intended that a planning session may be held in early Fall, 1968 at which time six to eight persons who would serve as resource people for the conference sessions would meet together and discuss the kind of prepared papers and training exercises that they feel would be of most value for the research training sessions. It is planned that these key people will then return to their campuses and refine their plans for leading training sessions to be held in November. Final plans for the training sessions will be completed in September.

Step 2. Fifty applicants will be selected for participation. Information regarding application procedure will be sent to members of NARST, and to selected journals for announcement. Race, creed, religion or geographic location will not be factors in selection. Priority will be given to applicants who are conducting or supervising research in science education. Professors in science departments who wish to gain education research competencies will be considered for participation. Applicants will be selected and notified by early October, 1968. A list of alternates will be established and selections from this list will be made as necessary.

Step 3. Final plans for the training sessions will be reviewed by the leaders on Thursday evening, November 12. Last minute adjustments in training sessions will be made, if necessary.

Step 4. Training sessions outlined for the project will be conducted November 13-15, 1968. In addition to a brief presentation by the session leaders, participants will engage in study exercises prepared by the leaders. For example, in the first session dealing with the use of learning theory in formulation of research hypothesis, participants will be given selected issues in science teaching and shown how to write research hypothesis bearing on these issues and consistent with elements of learning theory presented. Some exercises will be done individually and some in small groups. Evaluation leaders with guide discussion in the small groups, tapes of discussions will be selectively transcribed immediately for use in subsequent discussion sessions. Individual and group reports will be typed and duplicated for use by participants during the conference. Records of participants' successes and failures and other evaluation will be made.

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Step 5. A report summarizing accomplishments of the project and recommendations for further action will be prepared by the Director.

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TENTATIVE PROGRAM OUTLINE

for a

RESEARCH TRAINING PROJECT IN SCIENCE EDUCATION

~~Pick Congress Hotel~~, Chicago, Illinois, November 12-14, 1969

(This program outline would be modified by the planning conference proposed for June, 1968 at which leadership personnel would discuss resource papers they will prepare for November and correlated program activities.)

Session I. Wednesday, November 12, 1969, 9:00 A.M.
Chairman: Willard Jacobson ✓
Topic: Translating learning theory into research hypotheses in science education
Speakers: ~~Professor Lee Cronbach*~~ John A. Easley, Univ of Illinois
~~Herbert Klausmeir*~~
Joseph Novak*, ✓ Cornell University
Herbert Smith] Illustrations and applications
Milton Pella
Stephen Winter] (Evaluation leaders)

Session II. Wednesday, 2:00 P.M. - Continue session I.

Session III. Thursday, November 13, 9:00 A.M.
Chairman: Clarence Boeck
Topic: Identification of techniques and skills needed by science education researchers.
Speaker: Henry Walbesser*, University of Maryland
Robert Binger] Illustrations and applications
W. C. Van Deventer
John Montean (Evaluation leaders)
James Rutledge]

Topic: Experimental and Evaluative Designs — J Myron atkin
Speaker: ~~Stuart Westerland~~ J. Myron Atkin, University of Illinois
Robert Buell] Illustrations and applications
William Cooley
Clarence Nelson (Evaluation leaders)
Thomas P. Fraser]

~~Phil Jackson - Life in Classrooms~~

Session IV. Thursday, 2:00 P.M.
Chairman: T. Wayne Taylor*
Topic: Promising Research Directions in Science Education
Speakers: ~~J. Myron Atkin*~~
William Cooley*
James Becker] Illustrations and applications
Paul Blackwood
Robert Howe (Evaluation leaders)
Milton Pella]

*~~These individuals would participate in the conference planning session in~~ September.

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Session V. Friday, November 17, 9:00 A.M.
Chairman: Darrel Barnard
Topic: Technology and science education research design

1. CAI and research -- Ducan Hansen*
2. Evaluation of learning aids -- Wayne Welch* ✓
3. Audio-tutorial techniques and research -- Samuel Postlethwait

Evaluation sessions will follow each presenter.

Session VI. Friday, 2:00 P.M.
Chairman: James Robinson
Final evaluation and summary sessions:

1. Selection of research workers -- Frederic Dutton
2. Resources for research training -- Richard Harbeck
3. Changes needed in university programs -- Fletcher Watson
4. Research design and data analysis -- William Cooley

*These individuals would participate in the conference planning session in September

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Budget Summary

I. Trainee Support (50 trainees)	
Travel @$150.	$ 7500
Per diem 2 days x 50 @ $25	2500
II. Institutional Allowance -- none	
III. Direct Costs	
A. Personnel	
1. Program Director (J. D. Novak) Preparation prior to project sessions, preparation of final report 12 days @$100	1200
2. Professional Staff: Leaders of project training session who will prepare papers: 10 staff, 4 days each @$1000	4000
3. Secretarial: Mailing announcements, processing applications, preparing training materials and summary reports	
a. One secretary half time for 4 months @$200 per month	800
b. Secretarial group for transcribing and duplicating group reports at the conference 80 hours @$3.00	240
B. Consumable supplies	
Paper, worksheets	100
C. Travel	
Director and Professional staff 20 round trips @$150	3000
Per Diem 60 @$25	1500
D. Other Direct Costs	
Printing program, mailing, phone	500
Duplication and distribution of project reports	1000
Total Direct Costs	$22,340
IV. Indirect Costs	
Use of NARST facilities and resources for project execution 8% of Direct Costs	1,787.20
Total Budget Request	$24,127.20

OE 2241 (10-67)

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BUDGET BUREAU NO. 51

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
Washington, D.C. 20202

USOE USE ONLY

APPLICATION FOR PARTICIPATION IN THE EDUCATIONAL RESEARCH TRAINING PROGRAM

(P.L. 83-531, Section 2 (b), as amended by P.L. 89-10, Title IV)

USOE USE ONLY

1. Title of program A research training project in Science Education	2. Program period (from - to) 5/1/68 11/15/68	3. Amount $24,127.20
	4. Grant period (from - to) 5/1/68 12/31/68	5. Amount $24,127.20

6. Type of grant application
☒ New application
☐ Revision of grant no.______
☐ Continuation of grant no.______
☐ Supplement of grant no.______

7. Name and address of applicant institution (street, city, state, zip code)
National Association for Research in Science Teaching
E-30 McDonel Hall, Michigan State Univ., East Lansing, Michigan 48823

8. Subunits (give mailing address of last one listed)

9. Type of applicant, "x" one
☐ Higher education
☐ Educational agency
☐ State ☐ Local ☐ Private
☒ Other: specify Professional Science Education Non-profit Corporation

10. Type of training program, "x" one
☐ Undergraduate Training Program
☐ Graduate Training Program
☐ Postdoctoral Training Program
☐ Institute
☒ Special Training Project
☐ Program Development Grant
☐ Other: specify______

11. Name and address of payee of grant award check
National Association for Research in Science Teaching, E-30 McDonel Hall, Michigan State University, East Lansing, Michigan 48823

12. Name and address of grant fiscal officer
Dr. T. Wayne Taylor, Secretary-Treasurer, E-30 McDonel Hall, Michigan State University, E. Lansing, Michigan, 48823

13. Telephone
355-1725

14. CERTIFICATION

I the undersigned on behalf of the applicant institution accept, as to any grant awarded, the obligation to comply with USOE Regulations and Guidelines for the Educational Research Training Program in effect at the time of the award. I further agree to comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), and the Regulations issued thereto and state that the formally filed Assurance of Compliance with such Regulations (Form HEW-441) applies to this project. I also certify that there are no commitments or obligations including those with respect to inventions inconsistent with compliance with the above, and that trainees with such commitments will not be accepted for participation in the program.

15. Name and title of program director (please type) Joseph D. Novak		19. Name and title of offical signing for applicant institution (please type) Joseph D. Novak, President	
16. Address 3 Stone Hall Cornell University	17. Telephone 607 275-5410	20. Address Stone Hall, Cornell U., Ithaca, 14850	21. Telephone 607 275-5410
18. Signature	Date	22. Signature	Date

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OE 2241 (10-67)

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DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
Washington, D.C. 20202

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APPLICATION FOR PARTICIPATION IN THE EDUCATIONAL RESEARCH TRAINING PROGRAM

(P.L. 83-531, Section 2 (b), as amended by P.L. 89-10, Title IV)

USOE USE ONLY

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	4. Grant period (from - to) 5/1/68 12/31/68	5. Amount $24,127.20

6. Type of grant application
☒ New application
☐ Revision of grant no.______
☐ Continuation of grant no.______
☐ Supplement of grant no.______

7. Name and address of applicant institution (street, city, state, zip code)
National Association for Research in Science Teaching
E-30 McDonel Hall, Michigan State Univ., East Lansing, Michigan 48823

8. Subunits (give mailing address of last one listed)

9. Type of applicant, "x" one ☐ Higher education ☐ Educational agency ☐ State ☐ Local ☐ Private ☒ Other: specify Professional Science Education Non-profit Corporation	10. Type of training program, "x" one ☐ Undergraduate Training Program ☐ Graduate Training Program ☐ Postdoctoral Training Program ☐ Institute ☒ Special Training Project ☐ Program Development Grant ☐ Other: specify________

11. Name and address of payee of grant award check
National Association for Research in Science Teaching, E-30 McDonel Hall, Michigan State University, East Lansing, Michigan 48823

12. Name and address of grant fiscal officer Dr. T. Wayne Taylor, Secretary-Treasurer, E-30 McDonel Hall, Michigan State University, E. Lansing, Michigan, 48823	13. Telephone 355-1725

14. CERTIFICATION

I the undersigned on behalf of the applicant institution accept, as to any grant awarded, the obligation to comply with USOE Regulations and Guidelines for the Educational Research Training Program in effect at the time of the award. I further agree to comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), and the Regulations issued thereto and state that the formally filed Assurance of Compliance with such Regulations (Form HEW-441) applies to this project. I also certify that there are no commitments or obligations including those with respect to inventions inconsistent with compliance with the above, and that trainees with such commitments will not be accepted for participation in the program.

15. Name and title of program director (please type) Joseph D. Novak		19. Name and title of offical signing for applicant institution (please type) Joseph D. Novak, President	
16. Address 3 Stone Hall Cornell University	17. Telephone 607 275-5410	20. Address Stone Hall, Cornell U., Ithaca, 14850	21. Telephone 607 275-5410
18. Signature	Date	22. Signature	Date

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DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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SUMMARY OF EDUCATIONAL RESEARCH
TRAINING PROGRAM
(P.L. 83-531, Section 2 (b), as
amended by P.L. 89-10, Title IV)

USOE USE ONLY

1. Title of program A research training project in Science Education	2. Program period (from - to) 5/1/68 - 11/15/68	3. Amount $24,127.20
	4. Grant period (from - to) 5/1/68 - 12/31/68	5. Amount $24,127.20

6. Name and address of applicant institution (street, city, state, zip code)
National Association for Research in Science Teaching, E-30 McDonel Hall, Michigan State University, East Lansing, Michigan 48823

7. Subunits (give mailing address of last one listed)

8. Type of applicant Professional Science Education Non-profit Corporation	9. Type of training program Special Training Project

10. Number of trainees expected to participate

A. Program period
50 Grant supported students
____ Other students

B. Grant period
50 Grant supported students
____ Other students

11. Key professional personnel of proposed training program

Name	Degree	Discipline	Official title	Department

12. Summary of training proposal (limit to this space)

The purpose of this project is to train research workers and supervisors of research workers in science education in specific competencies necessary for improving the quality and quantity of research. Participants will learn to distinguish between problems requiring traditional research design and those requiring newer evaluative designs. They will learn how to write behavioral objectives for science instruction and techniques for evaluating the level of attainment achieved toward these objectives. The participants will learn to appraise the relative contribution derived from surveys and status studies in contrast to the more basic and widely applicable findings resulting from research on factors affecting student's cognitive growth in selected areas of science.

In addition, the project will identify additional talent to lead research training programs, serve as a model for research training "presessions" prior to annual meetings of science educators, and accelerate the productivity of research workers in science education.

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OE 2243 (10-67)

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DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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BIOGRAPHICAL SKETCH

(P.L. 83-531, Section 2 (b), as amended by P.L. 89-10, Title IV)

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1. Name (last, first, initial) Novak, Joseph D.	
2. Position title Professor-Cornell	3. Appointment date 6/1/67

4. Education Institution (name and address)	Degree/year received	Area of specialization
University of Minnesota	B.S. 1952	Biology-Mathematics
University of Minnesota	Ph.D. 1958	Science Education-Botany

5. Professional work experience Employer (name and address)	Dates From - to	Highest position held
University of Minnesota	1956-57	Instructor of Botany
Kansas State Teachers College	1957-59	Assistant Prof. of Biology
Purdue University	1959-67	Assoc. Prof. of Biology & Ed.
Cornell University	1967-	Prof. of Science Education

6. Research experience

1952-57 Research assistant - plant physiology
1957-59 Research on leccure-laboratory methods, instructional techniques
1959-67 Research on cognitive growth; learning theory applications

7. Major publications (not more than five)

1. A experimental comparison of a conventional and a projected centered method of teaching a college general botany course.
2. The role of concepts in science teaching
3. An integrated experience approach to learning (book)

8. Experience in developing and directing research training programs

Past President - Association of Midwestern College Biology Teachers - led an evaluation training program for curriculum sponsored by CUEBS.
Research training sessions at NARST meetings in 1962, 64, 66.

9. Staff status

☒ Regular full time ☐ Other: specify________________

10. Time allocation		Percentage of time				
		Teaching	Administration	Research	Other	Total
A. Institution	95					100%
B. Program	05	50		45	05	

11. Program responsibilities

Direct NARST training program including contacting key contributors and program planning

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DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
Washington, D.C. 20202

GPO : [illegible]

EDUCATIONAL RESEARCH TRAINING PROGRAM BUDGET

(P.L. 83-531, Section 2 (b), as
amended by P.L. 89-10, Title IV)

USOE USE ONLY

SUPPORT FOR GRANT PERIOD

I. TRAINEE SUPPORT

A. Stipends

1. Level and type	2. Stipend rate	3. No. of trainees	4. Amount
Professional		50	$ ---
5. Subtotal:			

B. Dependency allowance

1. Level	2. Rate	3. No. of depend.	4. Amount
Weekly	$ 15		
Acad. yr.	400		
Full yr.	600		
5. Subtotal:			

	Amount
C. Travel and relocation costs:	10,000
D. Total trainee support:	

II. INSTITUTIONAL ALLOWANCE

A. Based on rate per trainee

1. Level and type	2. Rate	3. No. of trainees	4. Amount
B. Total institutional allowance			$

III. DIRECT COSTS

A. Personnel 1. Type	2. Full-time	3. Part-time	4. Amount
Program director		1	$ 1200
Prof. staff		10	4000
Other staff Secretaries			1040
5. Subtotal:			6240
B. Consumable supplies			
Paper, Worksheets			100
Subtotal:			100
C. Equipment			
Subtotal:			
D. Travel			
Director and Prof. Staff			
20 round trips @ $150			3000
Per diem 60 @ $25			1500
Subtotal:			4500
E. Other direct costs			
Printing, Program, mailing, phone			500
Duplication, distribution of project reports			1000
Subtotal:			1500
F. Total direct costs:			$ 12,340

IV. TOTAL SUPPORT REQUESTED FOR PROGRAM PERIOD

Budget allocation	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	Total
Trainee support	$10,000					$
Institutional allowance	-------					
Direct costs	12,340					
Indirect costs [illegible]	1,787.20					
Total:	$24,127.20					$

NAME OF INSTITUTION	PROGRAM TITLE
National Association for Research in Science Teaching	A research training project in Science Education

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Appendix

G. Budget Summary

Budget Summary

	Budgeted	Expended
I. Trainee Support Travel and per diem	$10,000.	8750.58
II. Institutional Allowance -- none		
III. Direct Costs		
A. Personnel		
1. Program Director	1200.	1200.00
2. Professional Staff	4000.	3600.00
3. Secretarial Staff: half-time	800.	800.00
Secretarial Staff: conference	240.	158.74
B. Consumable supplies	100.	37.50
C. Travel Staff travel and per diem	4500.	1216.86
D. Printing, mailing, duplication, and telephone	1500.	1199.02
Totals	$22,340.	$16,962.70
IV. Indirect Costs 8% of Direct Costs	1,787.	1,357.02
Totals	$24,127.	$18,319.72
Payments Made to NARST		$21,715.00
Less Expenditures		18,319.72
Balance Due USOE		$3,395.28